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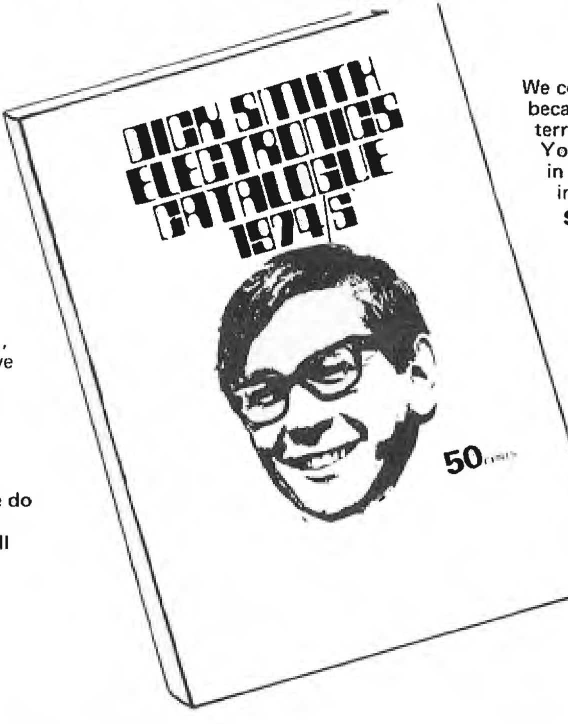

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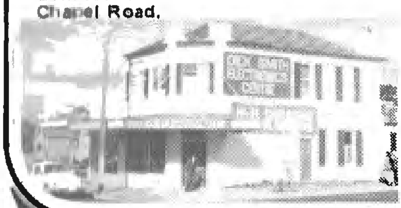

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VOLUME 1

SIMPLE PROJECTS

from electronics today INTERNATIONAL

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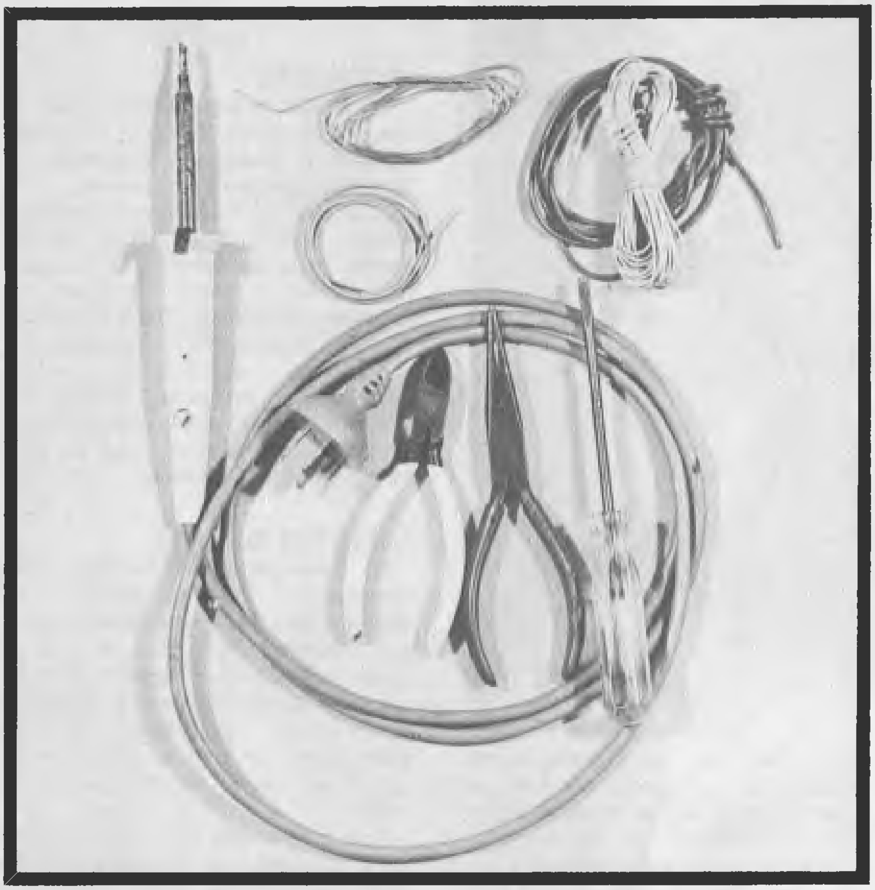
CONSTRUCTING ELECTRONIC PROJECTS

The how and why of project building.



Basic tools required to commence building projects, together with solder and wire. The tools are from left to right. Adcola soldering iron, side-cutting pliers, long-nose pliers and small screwdriver.

EVERYONE seems to be building electronic projects! The list of subscribers to our magazine Electronics Today reads like a cross-section of society. Readers include schoolboys and university professors, technicians and surgeons, council workers and bankclerks and they're all avid builders of ETI projects.

Why the fascination? We think it's because, from relatively few components, one can build a large variety of devices which are not only interesting but in many cases are also extremely useful.

The projects described in this book illustrate in a practical manner the diverse range of devices which can be successfully tackled by the beginner.

Most of the articles have been published before in Electronics Today and have proved very popular. Some new project articles are also included.

The different components used in these projects have been kept to a minimum and many components are common to several circuits. Additionally, many of the circuits described here are basic black boxes (such as the amplifier and power supply) which may be used again and again as part of other more complex projects.

Anyone building these projects will gain much insight into general electronics, will assemble a selection of useful circuits and will be well on the way to being a competent electronic experimenter and hobbyist.

THE TOOLS

Although the serious electronic hobbyist will ultimately finish up with a very extensive tool kit, very few tools are needed to get started on project building.

The most essential thing is a good soldering iron, the one we recommend is the Adcola M70, 19 watt iron, having a 3.2 mm (1/8 inch) tip. Also required are a pair of 100 mm diagonal side cutting pliers, and a small 100 mm screwdriver with a 3.2 mm blade.

As well as the above basic tools, you will require some resin-cored solder, some 20 to 22 gauge tinned copper wire, several lengths (different colours) of PVC-covered hook-up wire (7 x .010 or 10 x .010), and a length of 1 mm spaghetti-type insulation.

Do not try to use plumber's stick solder or anything but high grade 60/40 (60 per cent tin, 40 per cent lead) 5-core resin solder. Especially do not use any acidic fluxes — otherwise your components will corrode away!

Resin-cored solder is available in a number of thicknesses, or gauges. That most commonly available is 16 SWG, but this is a little heavy for today's compact circuitry and we suggest that you obtain 18 or 20 gauge if possible.

The above tools, wire and solder are all that is required to get going on matrix-board projects but for others you will also need a drill (preferably electric), a set of drill-bits and a couple of small files, one flat 150 to 200 mm and one round 150 to 200 mm. These will be required to make small heatsinks, to mount completed projects in boxes and to mount switches etc. ●

CONSTRUCTIONAL METHODS

Veroboard, matrix board, printed circuits — or tag strips.

ELECTRONIC PROJECTS may be constructed in several different ways. The simplest by far is by using a printed circuit board. Boards, etched and drilled for specific projects are readily available from most of the kitset and component suppliers who advertise in this magazine. Alternatively, pc boards (as they are usually called) can be made at home.

Other methods of construction include matrix board, Veroboard and tag strips. The pros and cons of each method are described in this article.

VEROBOARD

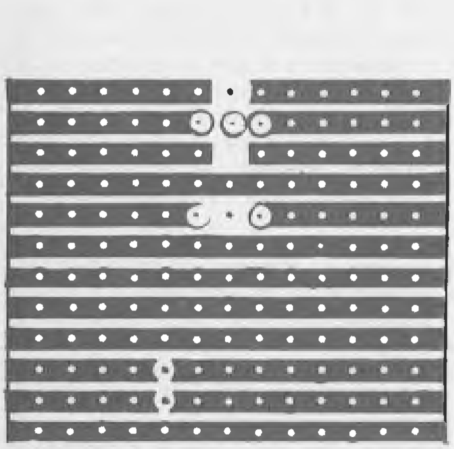
Veroboard is a commercial product specifically made for rapidly assembling prototype equipment, or for building one-off projects etc.

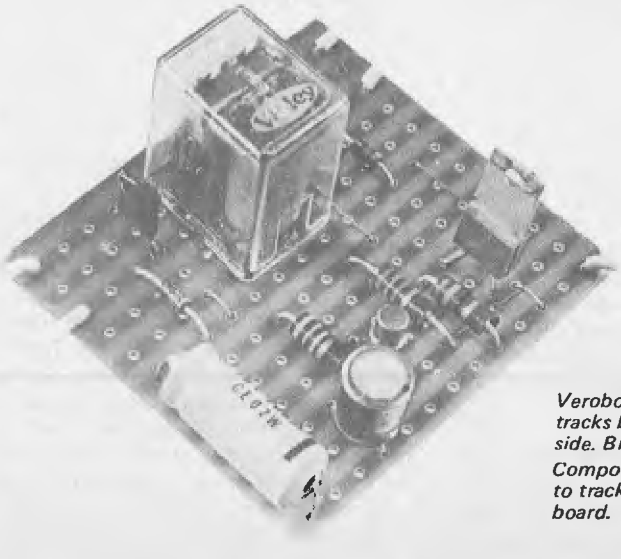
It consists of a high-grade laminated circuit board upon which parallel copper strips are bonded. The board is pierced by a matrix of holes, for inserting component. These holes may be at 0.1, 0.15 or 0.2 inch spacing. For miniature electronic work, incorporating integrated circuits, the 0.1 inch pitch is most commonly used, whilst for general electronics, the 0.15 inch pitch is very popular.

USING THE BOARD

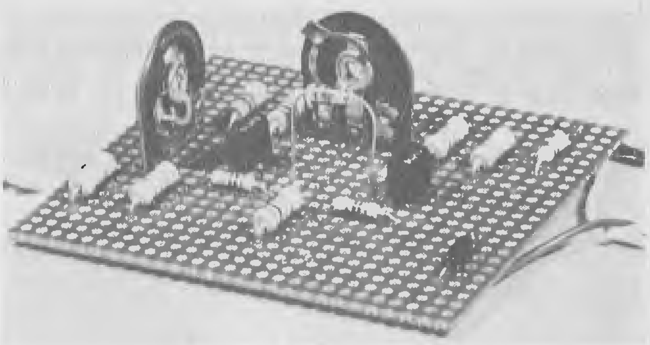
To assemble a circuit using Veroboard, the components are inserted into the board such that they are interconnected by the copper strips in the desired pattern. Where a break in the copper strip is required a sharp drill (as shown in the illustration) or a 'spot face cutter', specifically made for this purpose, is used.

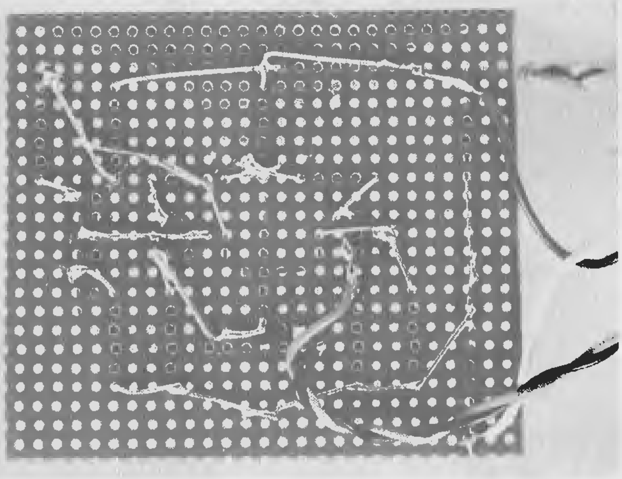
The components for a simple circuit may be placed on Veroboard in the same configuration that they have in the circuit diagram. This makes circuit





Veroboard — board has copper tracks bonded to non-component side. Breaks are cut where necessary Component leads are soldered to tracks on copper side of board.





MATRIX BOARD – Components are inserted through holes and leads soldered on non-component side. Novices find matrix board easy to use as components and wiring can be positioned exactly as on the circuit diagram.

checking much easier and any faults are subsequently easier to find.

Most connections may be made directly to the copper strip but, where strong connections are required, or where many wires are to be terminated at the one point, Veroboard pins may be inserted to make secure terminals.

MATRIX BOARD

Whilst Veroboard is very suitable for one-off equipment that is to be used permanently, it's rather difficult to strip and use again.

Matrix board, is more suitable for re-use in mocking up first prototypes but may also be used for equipment of a more permanent nature.

Matrix board is perforated with holes, in the same way as Veroboard, but does not have the copper strips. To use it one inserts the components through an appropriate set of holes and makes connections by routing the component leads at the rear of the board or, by using tinned copper wire to link the components. This sounds pretty messy, but it is surprising how quickly circuits can be built up and – how neatly they can be made.

Where component leads or the tinned hook-up wire cross they should be insulated by a small piece of insulating 'spaghetti'. This does not need to be done as often as one would think and quite complex circuits may be assembled neatly, compactly and speedily.

Matrix board is available in 0.25 inch or 0.1 inch spacings. The latter is preferable for miniature electronic work. Turret pins and eyelets are also available at low cost if required. Thus the matrix board system is ideal for assembling experiments as well as of one-off special equipment.

PRINTED CIRCUITS

Printed circuit boards simplify electronic circuit building enormously – to the extent that some enthusiasts feel that it is degrading the hobby to that of 'painting by numbers' – but of course you can always make your own circuits, as explained here.

The boards are made of a phenolic resin or glass fibre laminated with a thin copper sheet bonded (generally) to one side.

Intercomponent wiring is formed by etching away the unwanted copper – so that only the required tracks remain. Holes are then drilled for the components which are mounted on the non-component side and their leads soldered directly to the copper tracks.

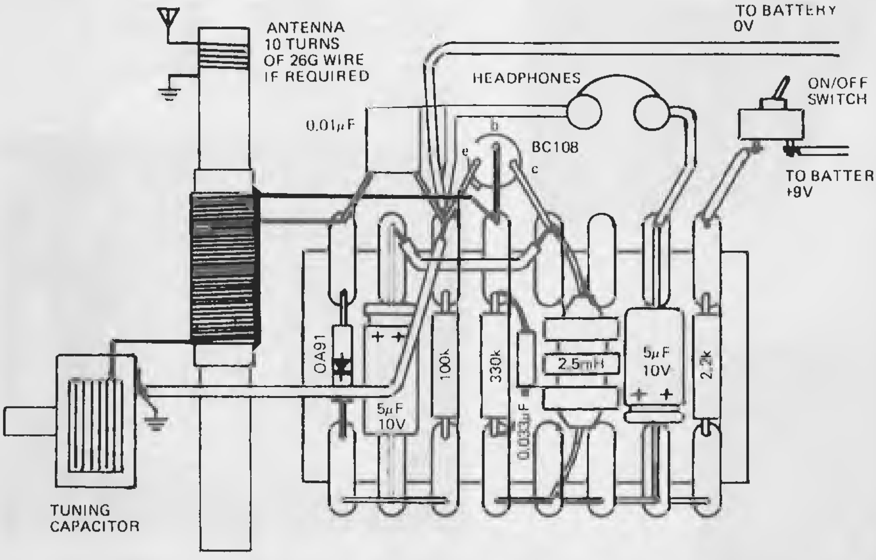
Most component and kit set suppliers stock printed circuit boards already drilled and etched for most popular projects. They also stock printed circuit board material for those who like to make their own boards.

There are very many different ways of etching printed circuit boards. The method described here is virtually identical to that used by our own projects laboratory at ETI. We use this method as in our experience it is the simplest, least messy way of making professional looking boards.

Although printed-circuit boards can be prepared for etching by painting the design on the board with bituminous or other etch-resistant paint or ink, one of the so called photo-resist methods is preferable by far.

Two methods are used – **negative resist** and **positive resist.**

The negative resist method is very effective, it is commonly used commercially but requires a photographic negative of the printed-circuit layout, whereas the positive resist process does not. Hence, using positive resist, a step which may



Tag Strips – construction is quick, cheap and simple. However the method is only really suitable for small scale projects as inter-tag wiring will otherwise be extensive and tedious. The method also wastes space. (Circuit shown is of a single transistor reflex receiver first published in our December 1971 issue).

CONSTRUCTIONAL METHODS

The artwork is prepared (full size) on a piece of transparent film using opaque PC board tape and pads. An original master is shown here together with an etched but untrimmed or drilled board.

The laminate should be thoroughly cleaned with paper towel and abrasive cleanser powder until the surface is uniformly bright, and wets uniformly.

The prepared laminate is coated with a thin film of 'resist' and allowed to dry.

Excess resist should be drained off and the board dried in a dark and dust free place.

The artwork is placed on top of the copper side of the board and sandwiched between a piece of foam and a sheet of glass. The board should then be exposed to light with a high ultra violet content for a time as detailed in the text.

After exposure the resist is developed (see text) the board allowed to dry and then etched in ammonium persulphate or ferric chloride solution. The board here is seen when partly etched.

be difficult for some experimenters is eliminated.

The process described here is based on the CCPR12 positive resist and associated developer available in NSW from Circuit Components or from suppliers of printed-circuit board materials in other States.

HOW IT WORKS

The copper surface of the board is coated with resist and then exposed to light through a piece of translucent film upon which the desired circuit pattern has been layed out with opaque artwork tape and/or ink. When subsequently developed the resist that has been exposed washes away leaving an etch-resistant pattern of the required circuit. The exposed copper may be etched away with ferric chloride or ammonium persulphate.

THE ARTWORK

Materials are available from suppliers for making the so-called 'artwork'. This is the required pattern laid-out full size with opaque tape onto Mylar film. Tapes of various widths are available, together with stick-on transistor and IC pads. Such materials, although relatively expensive, greatly facilitate making artwork.

1. LAMINATE PREPARATION

(a) Allow an 8 mm border beyond the finished board perimeter to simplify handling.

(b) Scrub laminate thoroughly with a powdered abrasive cleaner using a new Scotchbrite pad or clean paper towelling and water. (Do not use sponge type kitchen pads or steel wool, due to their susceptibility to grease retention).

(c) Hold scrubbed laminate under running water and check that the copper surface 'wets' evenly all over. If a break appears, rescrub and retest.

(d) Dry with a clean piece of paper towelling, being particularly careful not to touch the prepared surface of the laminate with the fingers. (Skin oils will contaminate the surface and nullify the preparation). Then brush the surface with a 'soft', clean brush to remove lint, dust etc.

2. COATING THE LAMINATE

(a) Pour a small pool of resist in the centre of the prepared laminate and thinly smooth over the surface with a ½" to 1" paint brush. (Use a new brush and keep for use with CCPR 12 Resist only. Wash brush in methylated spirits, then in soap and water). A "streaky" appearance when wet usually settles evenly during the drying process.

(b) Place coated laminate in a preheated oven at 80 to 90°C (176 to 194°F) for 10 minutes. This will dry the resist sufficiently for exposure.
It is recommended that ovens using exposed or infra red elements not be used as the red light may prevent the photo-sensitivity from functioning. Where these and gas ovens are employed, bring the oven up to temperature and switch off, then place the prepared laminate in the upper section of the oven for 15 to 20 minutes.

EXPOSING

Now place the artwork in intimate contact with the prepared board by sandwiching the board and artwork between a sheet of polythene foam and a piece of thoroughly clean glass.

The sandwich must now be exposed to light. This can be done in several ways — two of which are described below.

(a) Direct sunlight may be used — the exposure time should be four to five minutes.

(b) Using 2 x 20 watt Sylvania type F20T12-BL fluorescent tubes (or Philips Actinic Blue Fluorescent tubes, both makes being 3900 angstroms) mounted on a twin batten unit at a distance of 250 mm. A master made on single matte film typically requires an exposure time of four minutes. The time will vary depending on the film used (clear, single matte or double matte) and the distance between the tubes and the work. Clear film typically halves the exposure.

DEVELOPING

(a) To 1 litre of water add 40 grams of CCPD16 developer crystals. Place the solution in a glass or plastic tray. (Do not use aluminium containers as this solution is alkaline and will be contaminated by the aluminium).

(b) Immerse the exposed laminate in the developer and rock gently, avoiding splash. Another very satisfactory method is to lightly brush over the surface, while fully immersed, with a clean paint brush.
The exposed areas should dissolve completely within two minutes. This developer is not flammable, but should be treated with care. Always wash hands and other exposed skin areas as soon as possible.

(c) Rinse the developed laminate under running water and dry off with a soft cloth, then allow to stand in free air to stabilise for approximately 30 minutes.

(d) Where a very hard finish is needed, post baking at 100°C (212°F) for five to 10 minutes is recommended. Allow laminate to fully cool before etching.

ETCHING

Two suitable etchants are:

(a) **Ferric Chloride:** Yellow lump (hydrated). Mix 1 kilogram with each litre of water. To speed dissolving, heat the water to between 75 and 85°C (167° — 185°F).
Ferric Chloride: Anhydrous. Mix 500 grams with each litre of cold water. Important, add the powder to the water slowly stirring continuously, as this process generates extreme heat.
An ideal etching method for one or two small boards is to use a plastic paint roller tray and plastic handled nylon bristle hand broom. Place the board on the draining board, and the *cold* ferric chloride in the reservoir, then sweep the ferric chloride up and brush over the surface of the resist. This should be done at approximately one stroke per second. This should give an etch time of four minutes with a fresh solution of etchant.

(b) **Ammonium Persulphate:** Dissolve 200 grams in half litre of water. This solution should be heated to 40°C (100°F) but not above 50°C (125°F) for etching. Form a "basket" of plastic tubing and use a continuous "dunking" action until fully etched. Constant agitation is essential and a fresh solution should etch in five to seven minutes. This is a particularly clean etchant, but does not etch as much area as the same volume of ferric chloride. Note that this particular etchant is extremely slow when used cold.

Warning: Avoid spillages. If spilt or splashed, wash from affected areas immediately otherwise damage will occur.
When etching is completed, wash off in running water, then strip the resist off with methylated spirits or lacquer thinners. However if required this resist may be left on the finished board as it does not greatly impede soldering.
The resist is not a flux, therefore an electrical grade cored solder should be used in final assembly.

Warning: Exercise caution when using all chemicals, do not smoke, do not use the resist, thinners or methylated spirits near naked flame, and on no account use any utensil which has been used with chemicals for food or drinking purposes. Good housekeeping is essential for good results — keep all utensils clean and dust free. ●

SOLVING PC BOARD PROBLEMS

	PROBLEM	PROBABLE CAUSE
(a)	Resist will not "take" in spots (breaking surface tension).	Laminate not cleaned properly.
(b)	Resist will not wash off exposed areas during development.	(1) resist under-exposed (11) developer too weak (111) oven temperature too high
(c)	Resist washes away during development.	(1) board baked at too low a temperature (11) baking time too short (111) developer too strong (1V) board overexposed or has been exposed to ultra-violet light prior to development.

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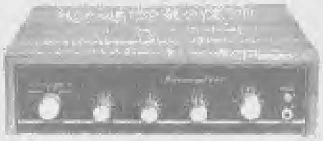

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ETI-SP

PROJECT
227

CRYSTAL RADIO

The classic beginners' circuit — no power supply is required.

ASK any of today's electronics buffs what was the first thing they ever built. Chances are it was a crystal radio set.

The crystal set is the simplest of all radios – and one of the earliest.

Its fascination is that it requires no external source of power – beyond that derived from the incoming signal itself.

A basic crystal receiver consists of an external aerial, a tuning circuit – that separates the desired signal from all other signals – a rectifying device, and a set of headphones.

In earlier days a crystal of galena was used to rectify the signal. The crystal was held in a metallic holder and a metal wire, called a cat's-whisker, was used to touch a sensitive part of the surface of the crystal. Sometimes much fiddling had to be done to find the best operational contact.

The cat's-whisker/galena crystal arrangement is of course responsible for the name given to this type of radio but nowadays we can use a much more efficient rectifier – the semiconductor diode.

Reasonable volume can be obtained from a crystal set providing a sufficiently long aerial is used. This must be mounted as high as possible. Something of the order of 20 metres long, mounted seven or eight metres high is fine.

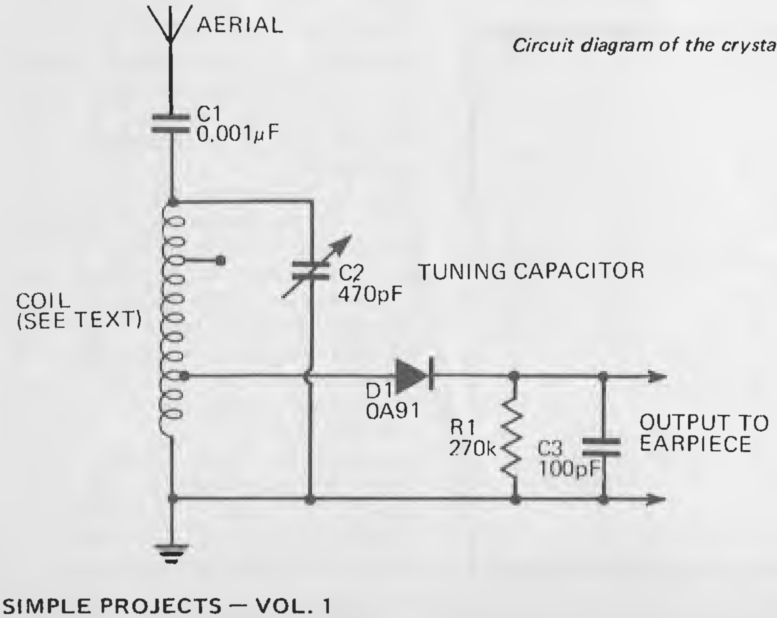
The headphones used should ideally have an impedance of around 2000 ohms. Suitable types are still available from many disposal stores. If these are not obtainable, a crystal earpiece such as is supplied with most transistors will do. These generally have a very high impedance and require a high voltage drive. Hence the volume will be lower, when using such an earpiece, but it will still work. ●

HOW IT WORKS

An aerial receives all the electromagnetic radiation in the area. Each signal source produces voltages across the antenna and unless these signals can be separated somehow, the information we require will be hopelessly scrambled by all the other signals.

To do this, the low frequencies are rejected by C1 and the remainder are impressed across the parallel arrangement of the coil and C2. Such a parallel LC circuit has a resonant frequency, determined by the values of L and C, at which its impedance is relatively high. At all other frequencies its impedance is low. Thus only the signal which coincides with the resonant frequency of the LC arrangement will produce a signal to be rectified by diode D1. By varying C2 we may vary the resonant frequency and hence tune to different stations.

The rectified signal is then filtered by R1 and C3 to recover the original audio modulation from the selected radio station carrier.



Circuit diagram of the crystal radio.

PARTS LIST –
Crystal Radio ETI 227

R1 Resistor 270 k ½ watt 5%
C1 Capacitor 0.001 μF
C3 Capacitor 100 pF
D1 Diode OA91 or similar
L1 Coil see Table 1 below
C2 Tuning gang single section 470 pF Roblan or similar
Coil former – piece of cardboard tubing (see Table 1).

TABLE 1.
Winding details of air-cored coil (close wound).

COIL DIA. mm	NUMBER OF TURNS VERSUS WIRE GAUGE			
	0.8 mm	0.63 mm	0.5 mm	0.4 mm
32				108
38			96	87
44		88	77	70
51	82	72	67	62
57	71	64	58	54
64	61	56	52	49
70	54	52	—	—

Note 1. Tap the coil every ten turns.
Note 2. For former sizes between those stated use an intermediate number of turns. This is not critical.
Note 3. Select the tap for the diode by determining which one gives best volume, whilst still adequately separating the stations.

THREE SIMPLE RECEIVERS

PROJECT 705 (A,B&C)

Biased diode; voltage multiplier; or solar powered — three simple but unusual receivers.

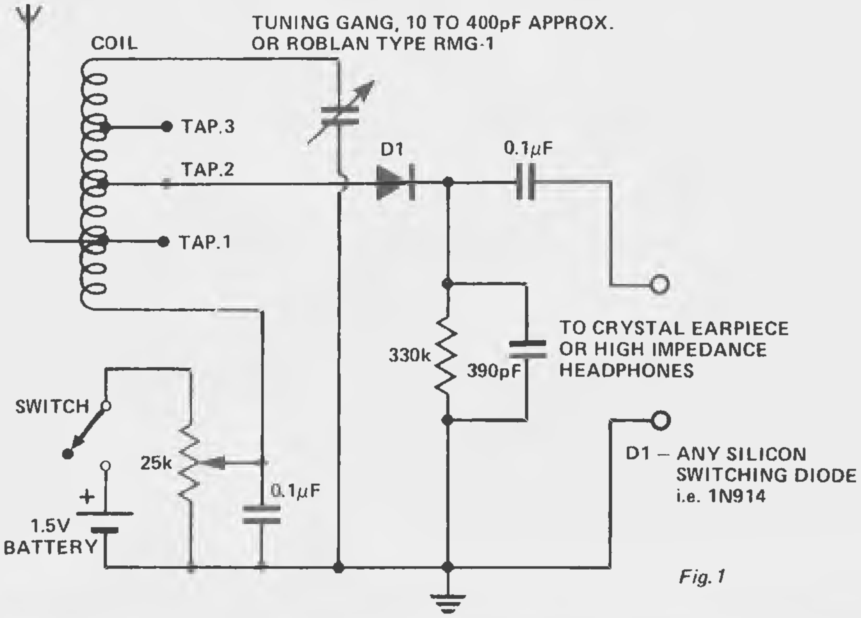

COIL
TUNING GANG, 10 TO 400pF APPROX. OR ROBLAN TYPE RMG-1
TAP.3
TAP.2
TAP.1
D1
0.1μF
TO CRYSTAL EARPIECE OR HIGH IMPEDANCE HEADPHONES
330k
390pF
SWITCH
25k
+
1.5V BATTERY
0.1μF
D1 – ANY SILICON SWITCHING DIODE i.e. 1N914

Fig. 1

BIASED DIODE CRYSTAL SET

THE CLASSIC "beginning beginner's" project is the crystal set — the workhorse of the pioneers and first popularised in the 1920's. For utter simplicity there is nothing to beat it. However, one can make various improvements and refinements on the basic circuit. One such refinement is shown in Fig. 1. In this version, a biasing voltage is impressed across the diode detector.

One failing of a basic crystal receiver (in which a diode is used as a detector) is that the diode will not commence conducting in the forward direction (from anode to cathode) until the anode-cathode voltage exceeds a certain (small) value. For germanium

VOLTAGE MULTIPLIER CRYSTAL SET

THE DIODE detector, as in a crystal set, is basically a special use of a rectifier circuit. Borrowing from rectifier circuitry, a 'voltage-multiplier' can be used to increase the output (the loudness in the headphones) of a crystal set. The circuit in Fig. 2 uses what is known as a 'Cockcroft-Walton' multiplier (after the original designers).

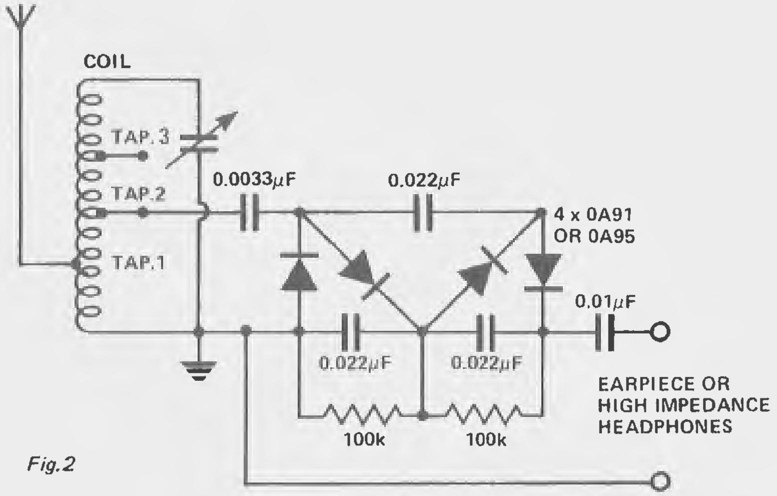


Fig.2

Here, a voltage multiplication of four is obtained. You may wonder 'why not use a higher multiplication?'. The answer is that one runs into the ubiquitious 'law of diminishing returns'. For this application, a multiplication of four is all that is practicable as any further increase results in excess load being placed on the tuned circuit, reducing sensitivity and the ability to separate stations (selectivity).

The coil details are the same as for Fig. 1 in the Biased Diode Receiver (see Tables 1 and 2 on page 13). See also the comments in the project concerning use of the taps on the coil. The best diodes to use in this circuit are OA2 or OA5 germanium diodes as they have the lowest forward conduction voltage and are thus the most sensitive.

Construction is also simple, matrix board and pins may be used here again. This tuning capacitor was salvaged from an old broadcast receiver (only one gang being used).

diodes, this is between 200 and 400 millivolts (0.2 to 0.4 V), for silicon diodes it is between 0.6 V and 1.0 V. However, if the diode detector has a voltage almost equal to its forward conditioning voltage impressed upon it (called 'bias') then it becomes a more sensitive and efficient detector. This arrangement also reduces distortion.

Construction is simple and not critical. The unit may be built up on a matrix board as in our prototype — or assembled on tag strips.

Coil details are given in Table 1. Find the best tap for the diode and the aerial by experiment. The aim is to find the combination which gives the clearest signals for the best rejection of unwanted stations.

For short length aerials, say three to six metres of wire, tap high up the coil or across the full turns. Make the diode tap about half-way to three-quarters of the way up the coil in this case. For a long aerial, use the lower taps and tap the diode between one-quarter and half-way up the coil.

The tuning capacitor used was salvaged from an old valve-type broadcast receiver (only one of the three gangs is used) but any unit having a range of about 10 to 400 pF may be used.

The best headphones to use for a crystal set are the high impedance type — having an impedance between 1000 ohms and 5000 ohms or more (if obtainable). Crystal earpieces may also be used but are not as sensitive as good headphones.

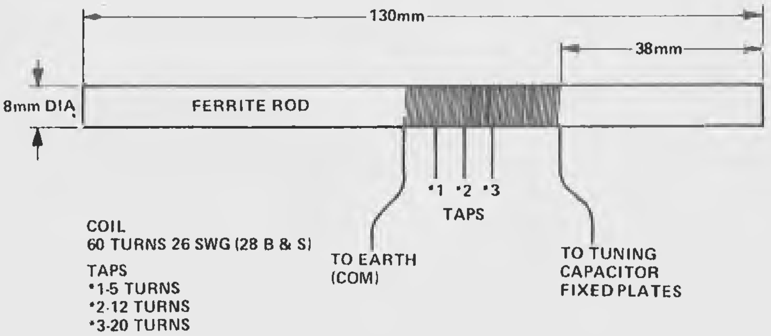
With the control potentiometer set at minimum, tune in a station that is not too strong but can be clearly heard. Advance the potentiometer slowly and an increase in volume and a reduction in distortion will be noticed. The point at which this occurs will vary from station to station but is not critical, there being some range of adjustment.

TABLE 1
For coils wound on cardboard former.

NUMBER OF TURNS FOR WIRE GAUGE

COIL DIA.	22 SWG	24 SWG	26 SWG	28 SWG	TAPS
1¼"				110	at ¼, ½ and
1½"			96	90	¾ of the turns.
1¾"		88	80	70	You may tap
2"	82	72	68	60	every ten turns
2¼"	71	64	60	52	if you wish
2½"	61	56	54	47	for more range
2¾"	54	52			of adjustment.

TABLE II Coil wound on ferrite rod



SOLAR-POWERED RADIO

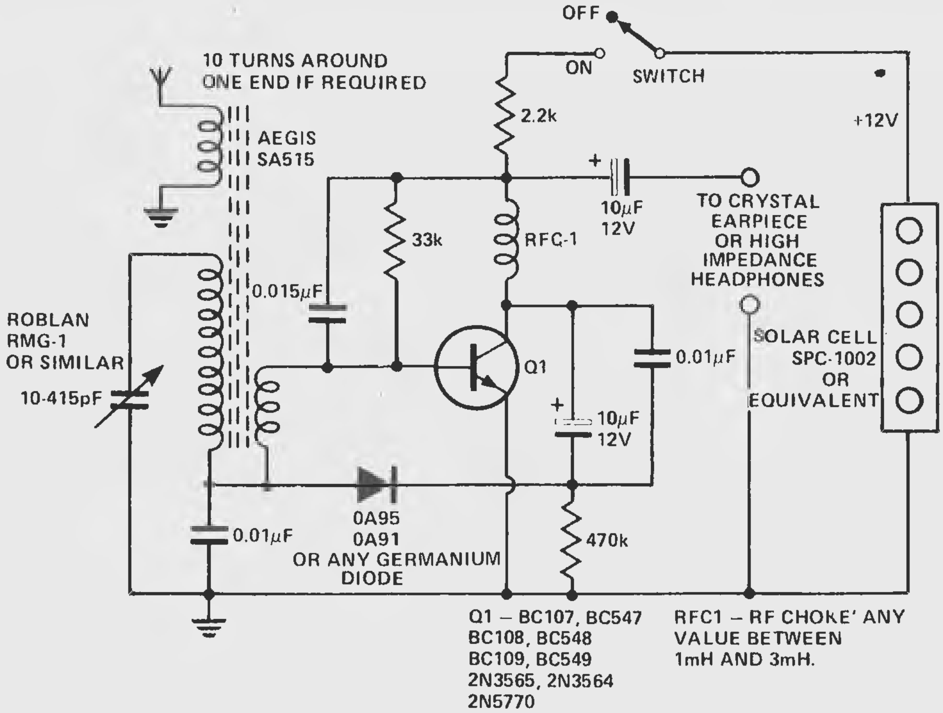


Fig.3. Solar powered reflex receiver.

SOLAR CELLS are dropping rapidly in price. They will continue to drop in price as they gain acceptance and use in more and more applications. Solar cells require no maintenance and the energy source (being the Sun) is free and presumably almost everlasting.

Modern solar cell arrays will deliver over one watt in bright sunlight from a single array, or about 200 milliwatts in cloudy conditions. A representative unit is the Solar Power Corporation's (USA) SPC-1002 (available from Joseph Lucas Pty. Ltd. in Australia). This consists of five wafers mounted on a printed circuit board, wired in series, and encapsulated. Output is about two volts. Similar units are available from other manufacturers.

The solar array can be used to drive a low-voltage radio receiver or to trickle charge rechargeable batteries such as the small nickel cadmium (Nicad) cells that are commonly available. These cells can be used to run a low voltage radio. Mercury cells, such as used in cameras, also make good low voltage power sources.

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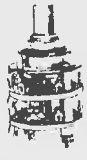

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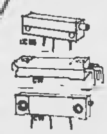

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BC 178	28c	23c
BC 179	28c	23c
BC 547	25c	20c
BC 548	25c	20c
BC 557	25c	20c
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EM 404	10c	8c
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THREE SIMPLE RECEIVERS

The circuit in Fig. 3 is a simple one transistor 'reflex' receiver that can be run from any of the above power sources, or a combination of them. It has been especially designed for maximum sensitivity using a low voltage collector supply. This supply may be of any voltage from two to four volts — but no more — it oscillates above that.

The transistor, Q1, amplifies both the radio frequency signal picked up by the ferrite rod antenna coil and the audio signals recovered by the diode detector. Thus both RF amplification and audio amplification are achieved using the one transistor. Surprising sensitivity is obtained, no external antenna is necessary in metropolitan areas — it even receives 2JJ in inner city Sydney suburbs!

If you live in the country, an external antenna may be necessary. A length of wire 10 m or more long, mounted 5 m to 10 m high is usually adequate. An added winding, as shown in Fig. 3, provides coupling for the external antenna. An earth connection may improve reception also.

CONSTRUCTION

Construction is straightforward and non-critical. Matrix board and pins, or tag strips are used to support the small components. Two rubber grommets are slipped over the ends of the ferrite rod and the assembly tied down to the matrix board with short lengths of *insulated* hook up wire around the grooves in the grommets.

As we said at the beginning of this article, solar cell arrays are still expensive. However, like so many other electronic components the price may realistically be expected to fall dramatically as soon as demand increases. At present, the cost of an array varies from $20 to $50 plus — but this may well fall by a factor of ten.

In the meantime, why not build it and run it from Nicad or mercury cells. These have terminal voltage of about 1.2 V to 1.3 V per individual cell, so two or three in series may be used to power this receiver. Current consumption from a two volt supply is about 0.5 mA. Alternatively, ordinary dry cells may, of course, be used. ●

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ONE-TRANSISTOR

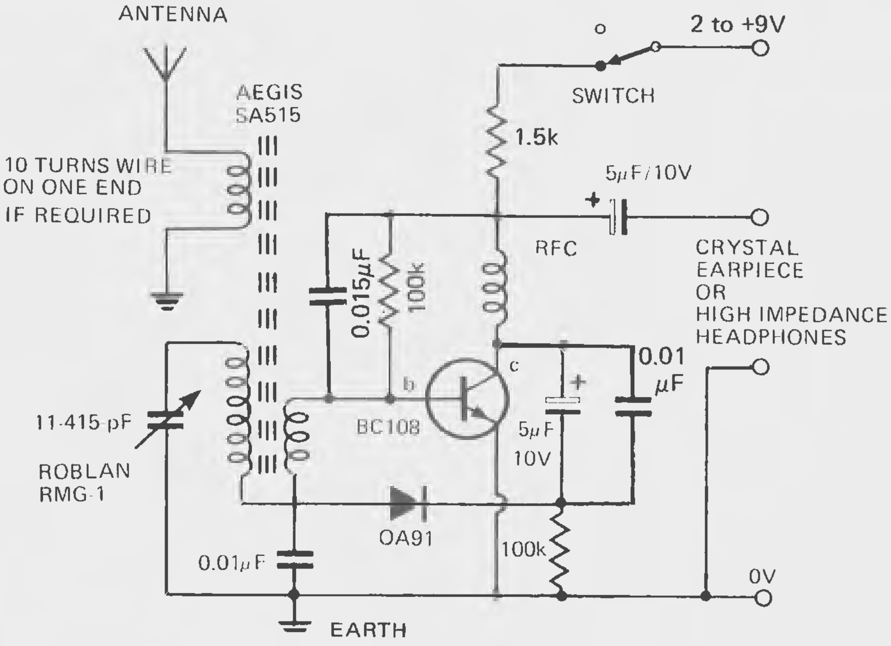


Fig. 1. Circuit diagram.

PROJECT 406

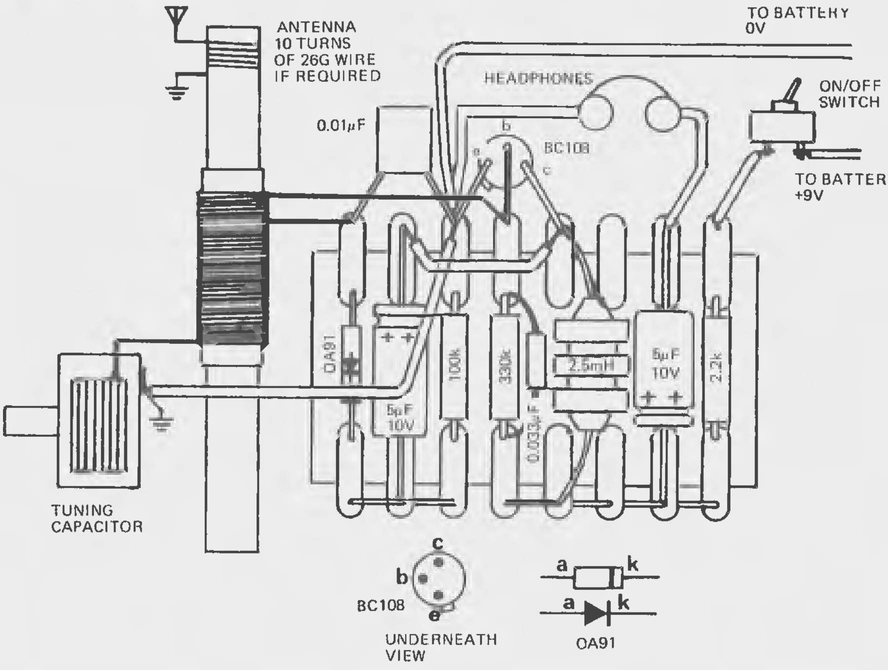


Fig. 2. The receiver may be built on tag strips or a piece of circuit board.

Here is a simple one-transistor receiver that will bring in broadcast stations with surprising clarity and strength. It can be made from readily available, cheap components, requires no adjustments, and will work straight off!

The circuit of the complete unit is shown in Fig. 1. A single transistor is used to amplify both the radio frequency signal picked up by the ferrite rod and coil antenna, and the audio signals recovered by the detector (OA 91 diode). This results in excellent sensitivity and selectivity ensuring that radio stations can be received at good strength and without interference.

CONSTRUCTION

The receiver can be constructed on a small piece of circuit board — as shown in Fig. 2. This can be mounted, together with the ferrite rod, tuning condenser, and battery and headphone connectors, on a piece of wooden board to which a panel has been screwed. This panel can be made from plywood, fibre-board, bakelite etc.

Two rubber grommetts should be fitted over the ends of the SA515 ferrite rod. These can then be fitted into the brackets (illustrated in Fig. 3) which are then screwed to the baseboard.

Take care when soldering the transistor into the circuit — leave this item until last.

ANTENNAE

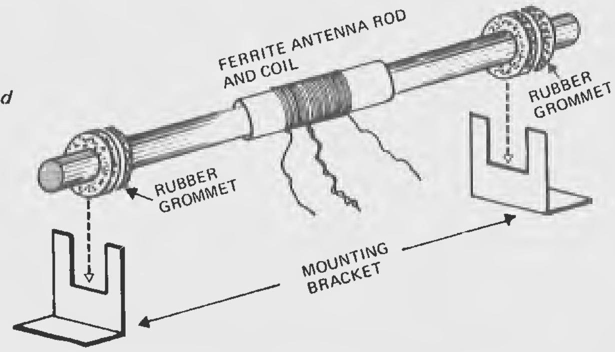
The AEGIS SA 515 ferrite rod acts as a built in antenna — and — if you live in the metropolitan area of a city, the local broadcasting stations will be heard at good strength with this antenna alone. At night some interstate stations may even be heard!

In fact an external antenna will probably be a disadvantage in city areas, because the received signal strength from nearby stations may be so powerful that distant stations will be swamped.

However if you live in a country area, then an external antenna may well be necessary.

Figure 4 shows the general idea. A length of wire, from 20 ft. to 100 ft. long should be erected, preferably in line with the nearest broadcasting stations, and as high as possible.

Fig. 3. The ferrite antenna rod and coil should be supported by two grommetts and small metal brackets.



Insulators should be used at either end. The type of wire is not important as long as it is strong enough to withstand wind forces etc.

An earth connection may also improve reception of weak signals. Use a length of metal rod or pipe, about two or three feet long, hammered into the ground. The surrounding soil should be kept moist. If mains water is available the water pipe will make a good earth – but ensure that it is a metal pipe. Many water systems are now being constructed using plastic pipes, and plastic water pipe is a remarkably poor conductor! ●

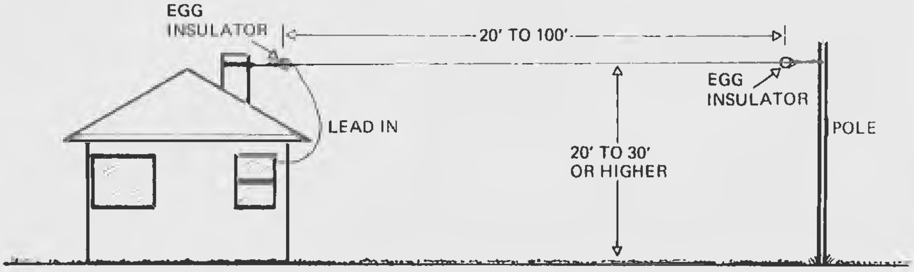


Fig. 4. How to make a simple antenna.

PARTS LIST ETI 406.

- 1 resistor 1.5k ½ watt, 10%
- 2 resistor 100k ½ watt, 10%
- 2 capacitors 5μF 10 volt electrolytic
- 2 capacitors 0.01μF
- 1 capacitor 0.015μF
- 1 transistor (Q1) BC107, BC108, BC109, BC547, BC548, BC549, 2N3564, 2N3565, 2N5770.
- 1 diode (D1) 0A91, 0A95 or any germanium diode
- 1 ferrite rod and coil – AEGIS type SA515 or similar
- 1 tuning capacitor 11-415 pF, Robland type RMG-1 or similar
- 1 nine volt battery and connectors
- 1 toggle switch – single pole single throw
- 1 RF choke, 1mH – 3mH
- 1 crystal earpiece or high impedance headphones
- 1 pointer control knob
- Rubber grommetts, screws, plywood etc.

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413	100W Power Slave. ½ rack mounting. Cannon inputs and outputs. **R.R.P. $135.00.** Standard kit still available for $75.00.
413-2R	2 x 413 mounted on rack panel. **R.R.P. $281.00.**
413-BR	2 x 413 bridged to give 200W RMS into 8Ω. **R.R.P. $281.00.**
414-16	16 channel sub mixer. Designed for use with 414 mixer. **R.R.P. $487.00.** Standard kit still available at $206.00.

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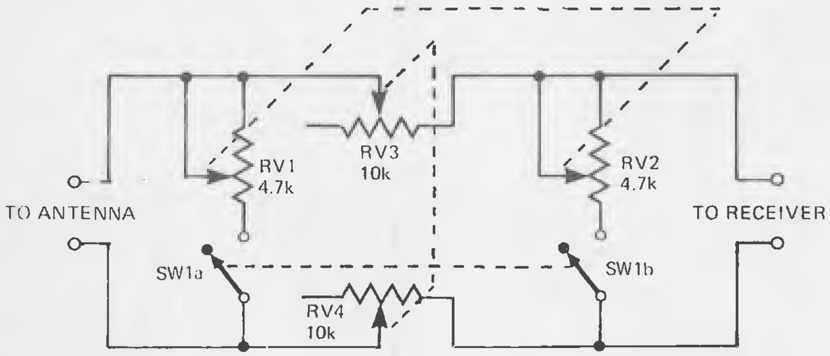
Simple project may well restore a previously unwatchable TV channel.

KILL THAT GHOST!

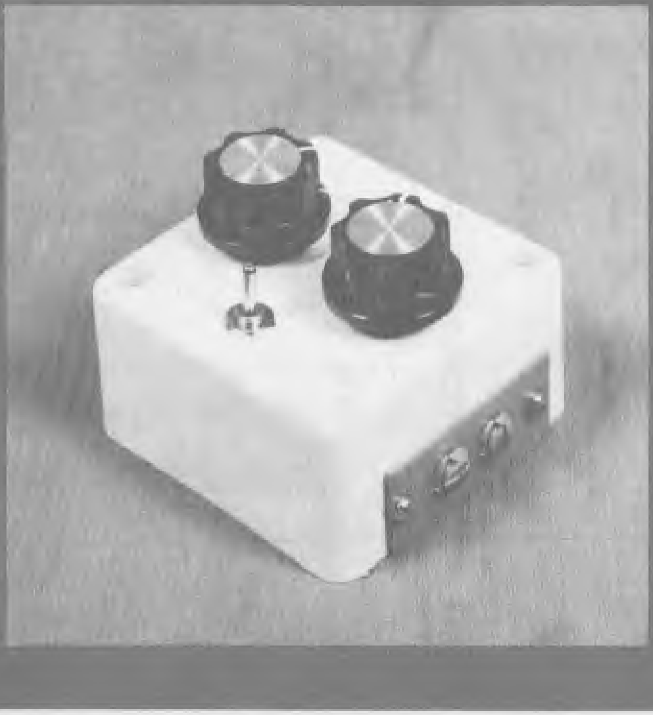
Fig. 1. Circuit diagram of the ghost eliminator.



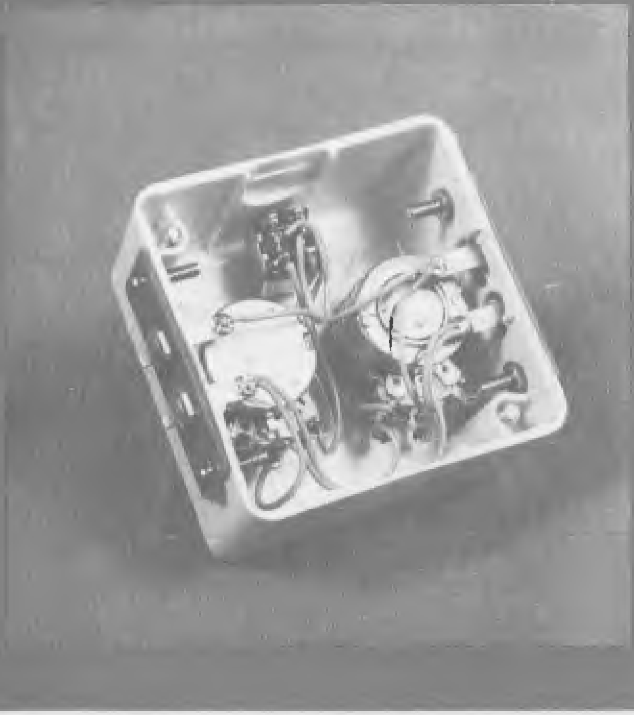
IF YOU live on a hill and have a direct line of sight to all TV transmitting antennas in your area you are fortunate indeed — for you will have an excellent, ghost-free picture on every channel.

Most of us are not so lucky. We may have good pictures on some channels, but another channel may be almost unwatchable due to 'ghosting' caused by multiple reflections.

The ghost eliminator may be built into any small plastic or metal box. This is how our prototype was built.



Internal lay-out of the connections may be seen from this photograph.



PARTS LIST

RV1/2 potentiometer dual-gang 4.7k
RV3/4 potentiometer dual-gang 10k
SW1 switch double pole single throw, connecting lugs, wire, plastic box.

PROJECT 216

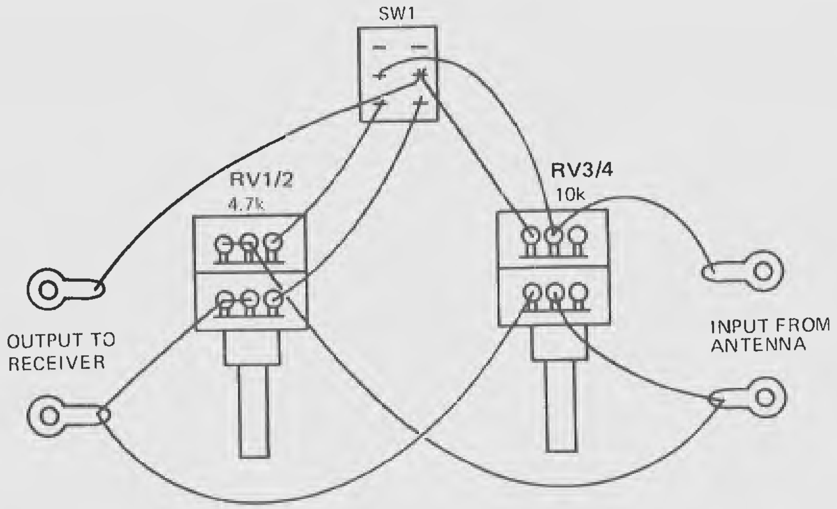


Fig.2. Point-to-point wiring diagram.

Providing that the signal strength on the offending channel is reasonable, this little project will attenuate the ghost and considerably improve the picture quality.

CONSTRUCTION

Construction of the ghost eliminator is quite straightforward. We constructed ours in a plastic junction box such as used by electrical contractors, but any small plastic or metal (mini box etc) will be suitable.

The circuit diagram is shown in Fig. 1 and Fig. 2 provides a point to point wiring diagram. Keep the internal wiring as short as possible.

Make sure you use the twin screw connectors as specified and keep the stripped portion of the antenna ribbon short so that an impedance mismatch is not created.

If you cannot obtain a dual 4.7 k potentiometer for RV1/2, a 10 k potentiometer, though more difficult to adjust, will be suitable.

USING THE ELIMINATOR

Switch SW1 to the 'OFF' position and adjust the dual gang potentiometer RV3/RV4 until the ghost is just eliminated.

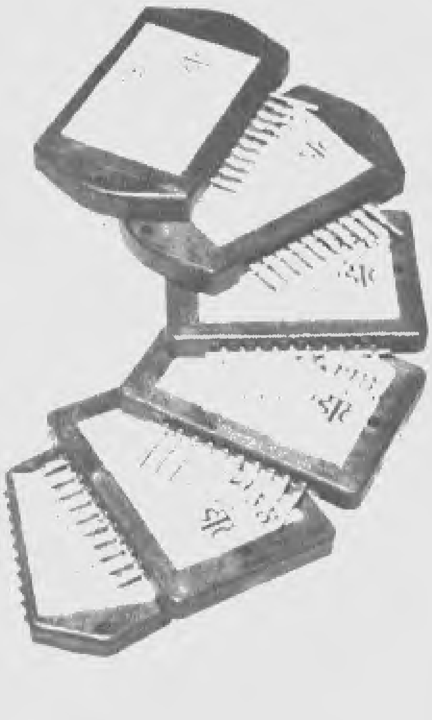
Now switch SW1 back on and adjust dual gang potentiometer RV1/RV2 for the best picture.

The eliminator may be connected to the antenna terminals of the TV set by a short length of aerial ribbon and just left hanging at the rear of the set. ●

---

6 EASY STEPS TO GOOD AUDIO!

TYPE	min.Watts 4 Ω	min.Watts 8 Ω	SUPPLY volts	Printed Bd. numbers
TA3C	3	–	13·2	370105
TA5B	8	5	25	339250
TA10B	13	10	32	339250
TA15B	18	15	38	339250
TA20C	30	20	±22	339771
TA25C	35	25	±24	339771
Preamp	–	–	–	339251



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TV MASTHEAD AMPLIFIER

PROJECT 701

Improve your TV picture (mono or colour) with ETI's cheap and simple project.

SPECIFICATIONS: MASTHEAD AMPLIFIER ETI 701

Gain	18 dB
Bandwidth:	40 MHz – 860 MHz, ± 1.4 dB
Noise Figure:	7 dB.
Output voltage:	80 mV for –60 dB intermodulation. Measured by DIN45004 method.

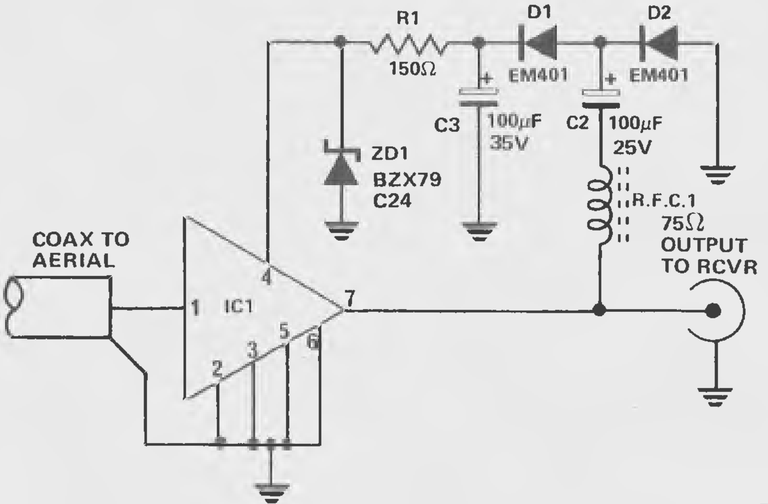


Fig. 1. Circuit diagram of masthead amplifier.

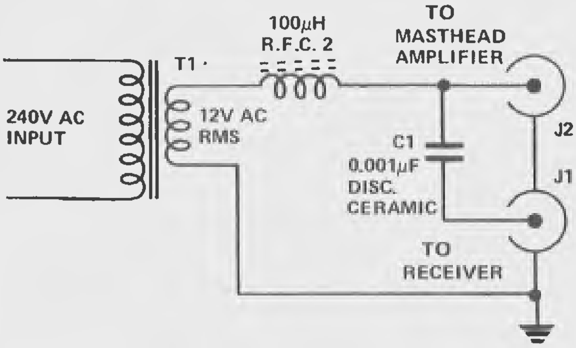


Fig. 1b. The power supply box circuit diagram. Note that outputs are taken to co-ax sockets on power supply box. Power is fed to mast-head amplifier via the signal co-ax.

OBTAINING a good TV picture in a poor reception area has always been a problem. And now that colour TV is here many people will have to re-assess their antenna requirements.

Not that colour TV really requires a better antenna but, after paying up to $1000 for a set, it is very disappointing to have a picture covered with 'hundreds and thousands' and plagued by ghost images.

SNOW

The effect, which appears as 'snow' on black and white sets is simply due to random electrical noise. The signal from the TV station, together with noise, is collected by the receiving antenna. The directivity and efficiency of this antenna therefore determines the signal-to-noise ratio available to the receiver.

If you are so unfortunate as to live in a poor-signal area you will need quite an elaborate antenna in order to achieve adequate performance. But, sometimes, even the best antenna you can afford is just not good enough. If the absolute signal level is not high enough to activate the receiver automatic gain control (AGC) – there will be snow on the picture.

GHOSTING

Ghosting may be caused by two factors, firstly by multipath reception due to reflection of signals by buildings and hills etc and secondly by signal pickup on the down lead. The first of these factors can only be eliminated by choosing and carefully locating, a suitable antenna. The second can be cured by using a feeder which is less prone to signal pickup.

The most commonly used feeder is 300 ohm twin ribbon. Whilst this cable does not unduly attenuate the signal, it is unshielded, and thus picks up signals and noise along its length. These signal voltages have a different phase relationship to those from the antenna and cause signal cancellation and ghosting.

The alternative to ribbon is 75 ohm coaxial cable. This eliminates the ghosting problem due to pickup but requires the use of baluns (matching transformers) and has a loss of between 4 and 6 dB per 30 metres (average). Thus the absolute amplitude of signal from the antenna will be degraded even with moderate feeder length.

However most colour TV sets are fitted with 75 ohm coaxial input sockets and it would be sensible to use coax – ghosts in colour can be quite objectionable.

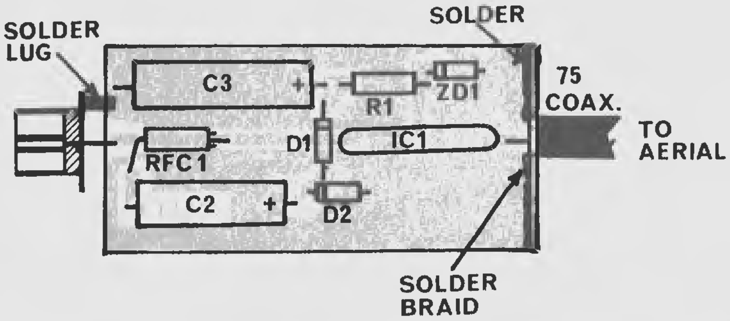


Fig. 2 Component overlay. Note piece of board soldered to right hand end of main board.

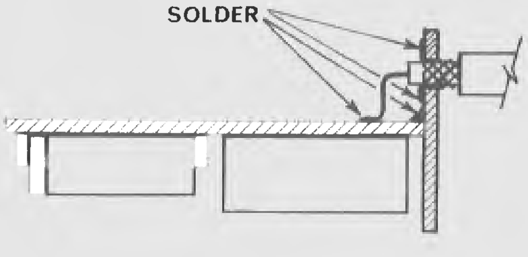
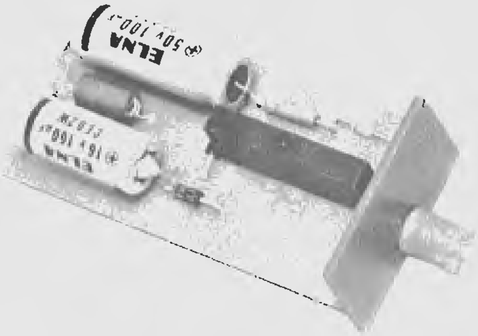


Fig. 3a. Side view of manner in which coax and end plate are fitted to main board. 3b. The completed assembly prior to assembly into the box.



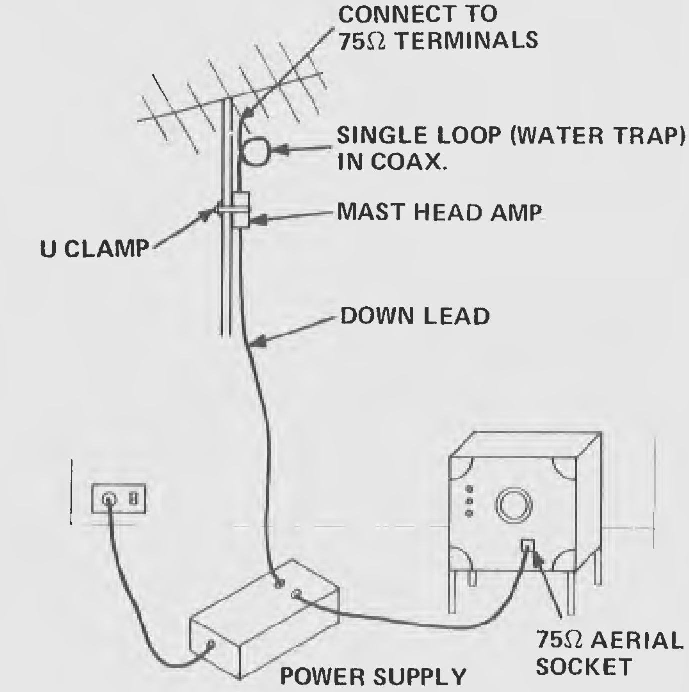
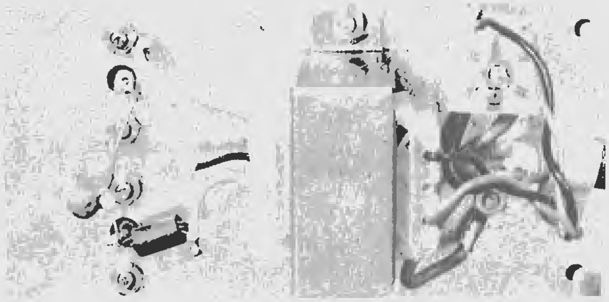


Fig. 4. How the amplifier is fitted to an existing system. Note that where the antenna was previously used with 300 ohm ribbon a balun must be used to match the antenna to the 75 ohm coaxial cable.



Internal view of the power supply box.

In low signal areas the consequent loss of signal level may be unacceptable. In such situations the use of a mast-head amplifier will compensate for cable loss and boost the signal to a suitable level for correct AGC action.

A mast-head amplifier is also essential where several sets must be fed from a common antenna. For such applications a splitter matching pad network must be used which results in 3-6 dB loss for each added set.

Note that adding an amplifier (which must be located at the masthead — not at the receiver terminals) will only *maintain the signal-to-noise ratio already present at the antenna terminals.* It cannot improve the quality of weak signals.

Constructing wide-band VHF amplifiers is quite tricky and generally not something to be tackled by the home constructor without experience in this field, however the availability (from Philips Elcoma), of a new thin-film, hybrid, integrated VHF-UHF wide-band amplifier has made this project both feasible and economic.

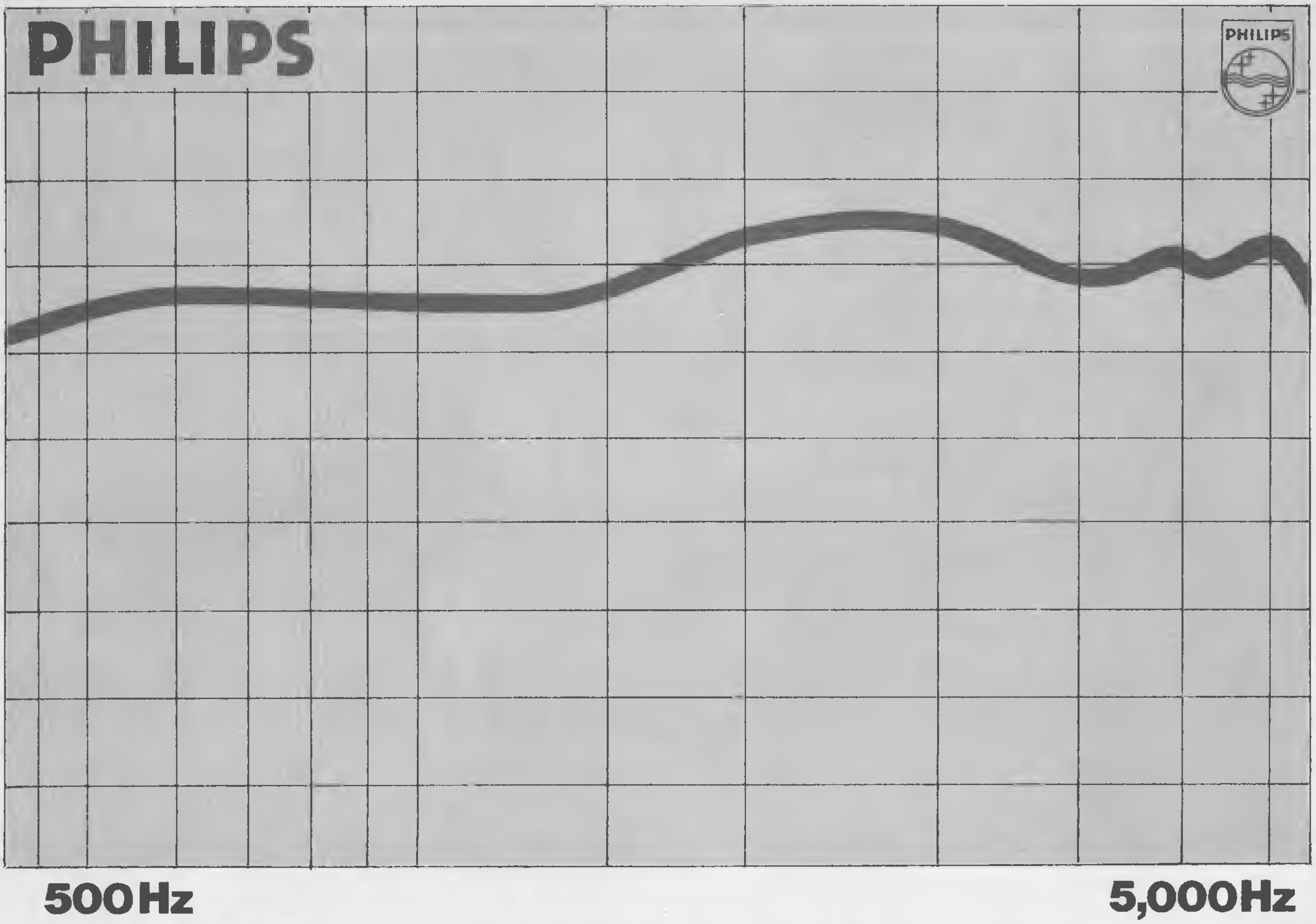
The sample we obtained from Elcoma bore the type number of OM190. These have since been re-numbered OM321. They are identical electrically, but encapsulated differently. So initially both types may be offered and either may be used.

The gain of the OM321 is about 18 dB, it has a flat response from 40 MHz to about 1 GHz, and its noise figure is the same as most modern solid state tuners — around 7 dB. Conventional wide-band amplifiers are prone to overload however this one is quite tolerant.

Should you encounter overload problems, first try a simple attenuator ahead of the input. Otherwise a channel trap tuned to your local low channel should eliminate the interference. (These devices are commercially available from most antenna suppliers).

CONSTRUCTION

Mount the components on the printed circuit board in accordance with the component overlay. Pay particular attention to the orientation of capacitors and diodes. Place the PC board into the diecast box, copper side up, and solder the end piece to the board. Take a length of co-ax (about a metre), and strip back the vinyl cover 20 mm



500–5,000Hz and it's almost flat. How's that for about $50 worth!

It's the performance curve of Philips new mid range speakers. That curve is so flat it gives a variation of as little as ± 1 dB over the same frequency spread. And even beyond those levels the drop is gradual on either side. And to think this performance is now available for about the $50 mark. Not bad for a 50 Watt dome squawker speaker. For further information please contact

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TV MASTHEAD AMPLIFIER

HOW IT WORKS – ETI 701

Power for the amplifier is provided from a step-down transformer mounted in a small box which can be located in the vicinity of the set. The secondary supply from the transformer is fed to the masthead unit, via the coax, where it is rectified, and voltage doubled by diodes D1 and D2 and capacitors C1 and C2. The resultant supply is then stabilized at 24 volts dc by ZD1. Lower supply voltages could be used but at the expense of overload margin.

The radio frequency chokes in either unit are incorporated to separate the signal and supply voltages. Power is transmitted up the feeder as ac, rather than dc, to prevent corrosion due to electrolytic action. The signal is coupled out to the receiver, from the transformer box, by capacitor C1.

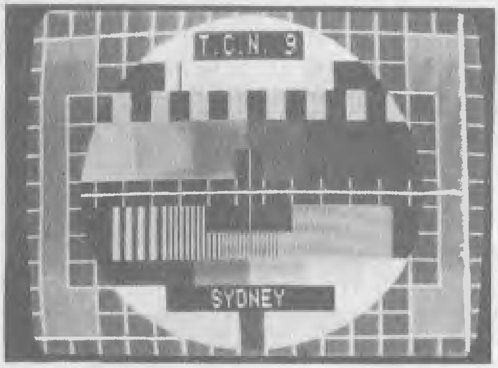


Fig. 5a. TCN9 test pattern received in a good signal area.

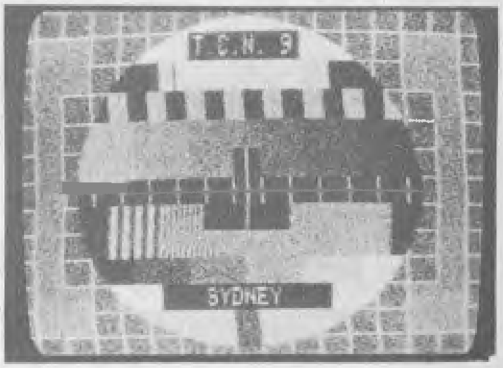


Fig. 5b. The same test pattern on a receiver with 16 dB less signal.

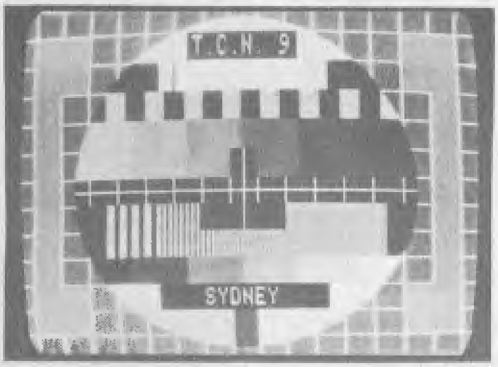


Fig. 5c. As in Fig. 5b but with the masthead amplifier fitted.

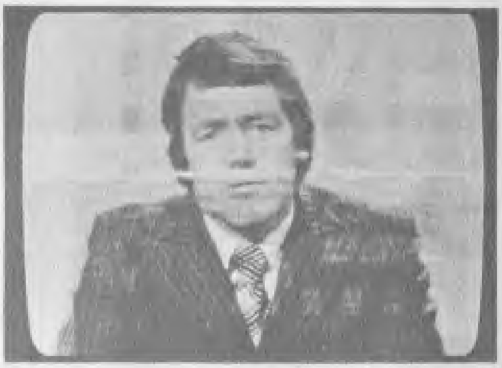
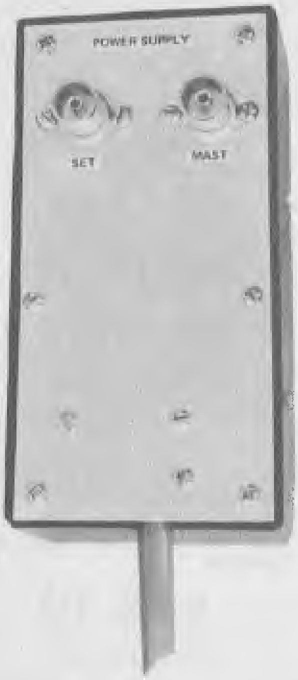


Fig. 5d. When using a wide band amplifier, too much signal on one channel may well interfere with other weaker ones. Here channel ABN2 is interfering with channel Ten. A simple attenuator ahead of the amplifier may be adequate. (If other channels are not too weak) alternatively use a trap on the strong channel to selectively reduce its level.

from each end. Comb out the braid and cut away the exposed polythene core. Solder one end to the board as shown in the diagram and attach two solder lugs to the other. Check all terminations for dry joints. The final stage is to encapsulate the masthead amplifier in an epoxy resin, but first check that everything is working! Seal the free end of the co-ax with epoxy to ensure that no water can penetrate. It is also important to ensure that water cannot penetrate the main co-ax via the Belling Lee plug. The die cast box can then be simply attached to the mast with a U clamp.

As most new antennas and sets have provision for 75 ohm terminations we have not included baluns in the design. If your antenna and set has only 300 ohm terminations, you will need to interpose a balun at both the antenna and set connections. These are available from the usual suppliers of antennas. ●



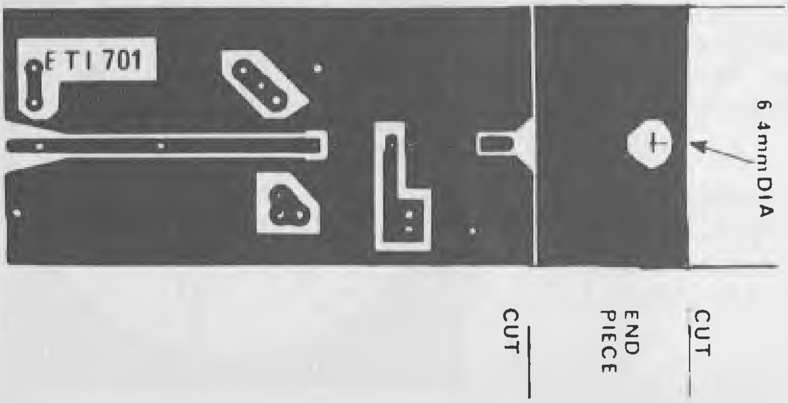


Fig. 6. Printed circuit board for the masthead amplifier. Note that the small piece at the right hand end is cut off and soldered to the main board as shown in Fig. 3.

PARTS LIST – ETI 701

R1 Resistor 150 Ω ½ W 5%
C1 Capacitor 0.001 μF 630V disc ceramic
C2 " 100 μF 25V electrolytic
C3 " 100 μF 35V electrolytic
IC1 Integrated Circuit OM321 or OM190 (Elcoma)
ZD1 Zener Diode BZX79C24
D1-D2 Diode EM401 or equivalent
RFC1,2 RF choke, 2½ turns on Elcoma 4312-020-36640 6 hole ferrite bead.
T1 Transformer 240V/12V DSE 2851 or similar.
J1,2,3 Socket L604/S Belling Lee or similar.
P1,2,3 Plug L734/P Belling Lee or similar
PC board ETI 701, Die cast box Eddystone 7968/P or similar, Zippy box UB1 (Dick Smith) or similar
3 core flex and plug, cable clamp, 3-way terminal block, solder lugs, 75 ohms coax.
Baluns 300 ohm to 75 ohm — Elcoma 3102-108-33091 or similar.

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1,000 ohms per volt. DC/V: 15, 150, 1000. AC/V: 15, 150, 1000. DC/mA: 1mA, 150 mA. Ohms: 1K to 100 K. Size: 2¼" x 1¼" x 3½".

$6.95

plus 15% Tax.

RAPAR SK33

Movement protected

10,000 ohms per volt. DC/V; 0.5, 2.5, 10, 50, 250, 1000. AC.V: 10, 50, 250, 500, 1000. DC.mA: 0.1, 25, 250. Ohms: 1Ω to 3 Meg. in three ranges. Size: 5" x 3½" x 1½".

$17.33

plus 15% Tax

RAPAR SK120

Movement protected

20,000 ohms per volt. DC/V: 0.6, 3, 12, 60, 300, 1200. AC/V: 6, 30, 120, 300, 1200. DC/mA: 0.06, 6, 60, 600. Ohms: 2 ohms to 8 Meg. in four ranges. Size: 5¾" x 3¾" x 2". Leather carry case available.

$19.80

plus 15% Tax.

RAPAR M303

Movement protected

30,000 ohms per volt. DC/V: 0.6, 3, 12, 60, 300, 1200. AC/V: 6, 30, 120,300, 1200. DC/mA: 0.06, 6, 60, 600. Ohms: 2 Ohms to 8 Meg. in four ranges. Size: 5¾" x 3¾" x 2". Leather carry case available.

$21.00

plus 15% Tax.

RAPAR SK100

Movement protected

100,000 ohms per volt. DC/V: 0.6, 3, 12, 60, 300, 600, 1200. AC/V: 6, 30, 120, 300, 1200. DC/mA: 0.012, 0.3, 6, 60, 600, 12A AC. Ohms — 1 ohm to 20 Meg. in four ranges. Size: 7" x 5¼" x 2½". Leather carry case available.

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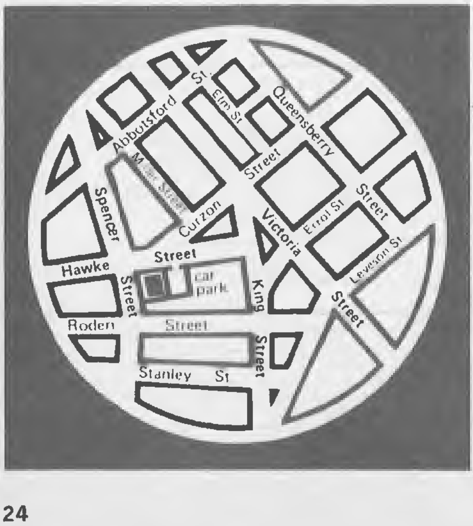

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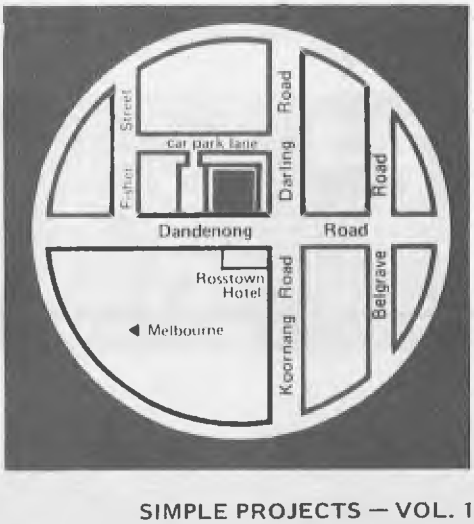


PROJECT 431 FM ANTENNA

Here are two simple-to-make antennas.

AUSTRALIA'S new FM broadcasting network will be well under way by the time this book is published.

Stations will be operational in all capital cities and coverage will eventually be nation-wide.

If one lives fairly close to the transmitter, a simple folded dipole like that shown in Fig. 1 may be adequate. However for those who live in the outer suburbs, or in localities where the direct signal is obstructed by building or local topography, a more elaborate antenna will be required.

Figure 2 shows a simple way of building a three-element Yagi array. This antenna gives at least 6 dB more gain than does a simple folded dipole.

The antenna may be constructed exactly as shown – or modified to suit available materials. It is fairly important to retain all dimensions as shown (designed for mid-point of the Australian FM band). The two halves of the main (centre) dipole must be insulated from each other.

Locate the antenna as high as possible. Most transmitting antennas will be 'horizontally polarised' – so the receiving antenna should be in the same plane. However if your local station has a vertical polarised antenna (Sydney's 2MBS-FM has at present but plans to change) then the receiving antenna should be similarly mounted (as shown in Fig. 4).

If motor vehicle ignition noise is a problem, locate the antenna at the rear of the house so that the house itself shields the antenna from RFI.

The antenna's impedance is 75 ohms and, if the FM tuner can be located fairly close to it by far the best way of connecting the two together is to use 75 ohm co-axial cable. But co-ax is quite expensive (about $1.50 a metre) so if you have a longish run it is cheaper to use an impedance matching 'balun' (about $2.50 from most TV parts suppliers) and 300 ohm ribbon. If you do use ribbon, keep it at least 100 mm from any nearby metal and twist it twice per 330 mm to prevent multipath interference due to signal pickup on the ribbon itself. ●

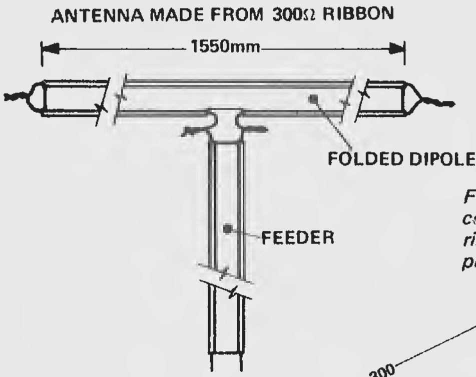


Fig. 1. This simple folded dipole may be constructed from a short length of 300 ohm ribbon tied in position or tacked to suitable pieces of wood or hardboard.

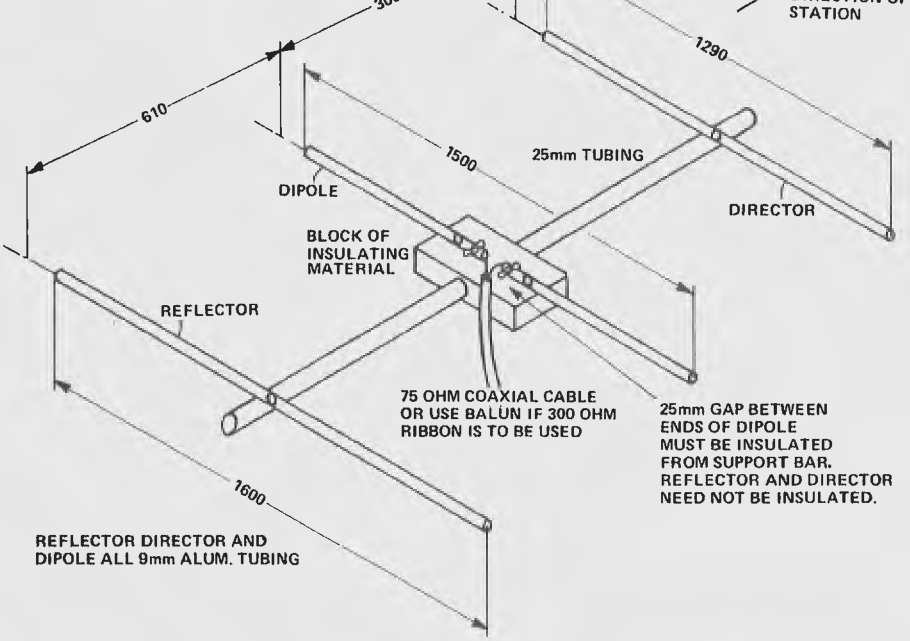

300
610
1290
DIRECTION OF STATION
1500
25mm TUBING
DIPOLE
DIRECTOR
BLOCK OF INSULATING MATERIAL
REFLECTOR
75 OHM COAXIAL CABLE OR USE BALUN IF 300 OHM RIBBON IS TO BE USED
25mm GAP BETWEEN ENDS OF DIPOLE MUST BE INSULATED FROM SUPPORT BAR. REFLECTOR AND DIRECTOR NEED NOT BE INSULATED.
1600
REFLECTOR DIRECTOR AND DIPOLE ALL 9mm ALUM. TUBING

Fig. 2. Main details of three element antenna – constructional methods may be altered but dimensions should be kept as shown.

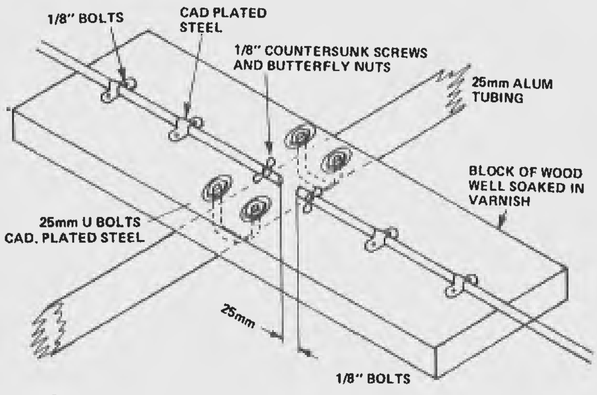

1/8" BOLTS
CAD PLATED STEEL
1/8" COUNTERSUNK SCREWS AND BUTTERFLY NUTS
25mm ALUM TUBING
BLOCK OF WOOD WELL SOAKED IN VARNISH
25mm U BOLTS CAD. PLATED STEEL
25mm
1/8" BOLTS

Fig. 3. Expanded view of centre part of Fig. 2.

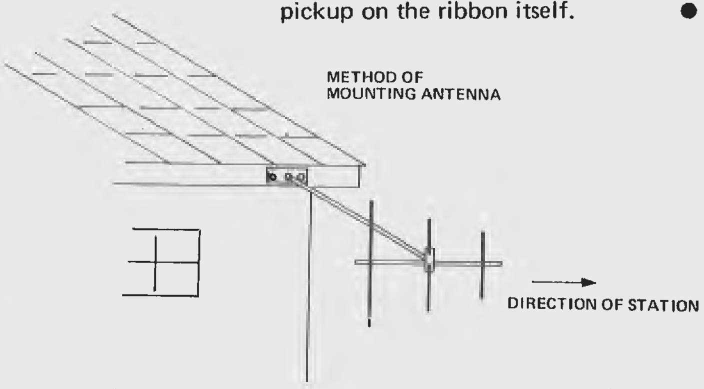
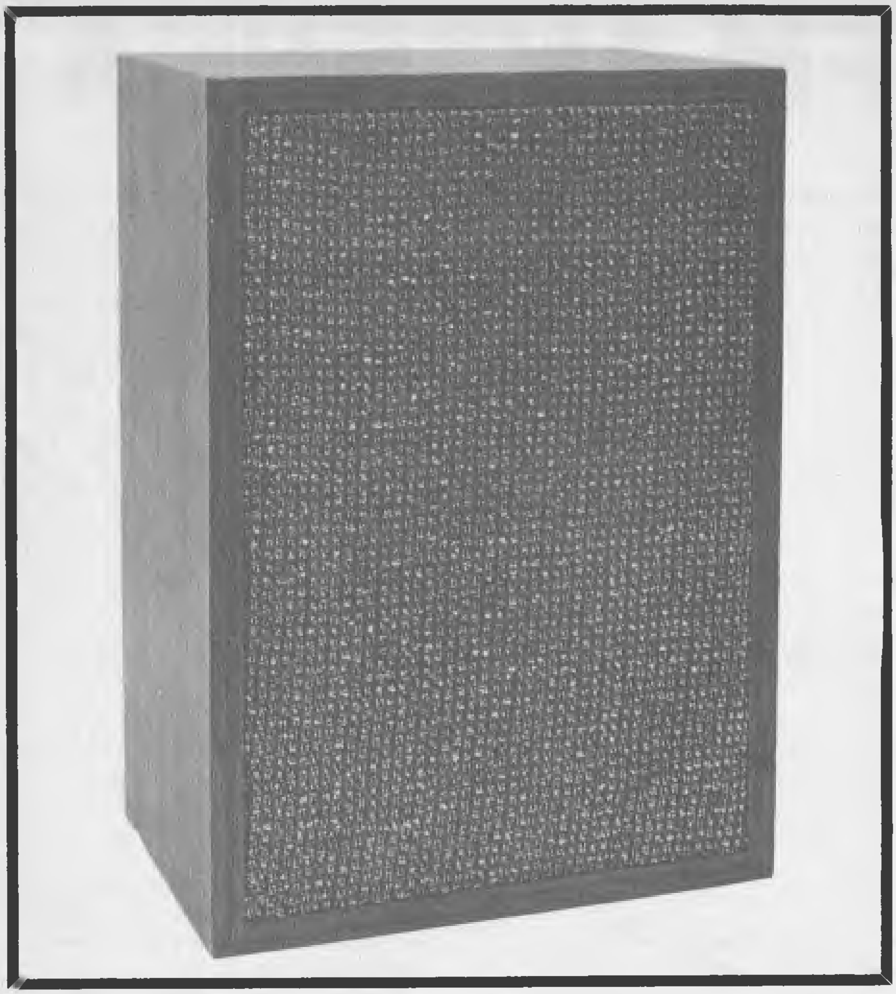


Fig. 4. How the antenna may be mounted. Elements should point in main direction of station – final position should be determined by moving around until maximum signal strength is obtained.



PROJECT 437

SIMPLE SPEAKER

An inexpensive unit with big sound.

EVEN if funds are very limited it is still possible for the beginner to build himself a pair of speakers that have a reasonable sound as well as good appearance.

The enclosures described are suitable for use with 150 or 175 mm speakers of the wide range type. We used the Philips AD 7061/W8, which is quite inexpensive, but almost any other wide-range speaker having similar dimensions will do.

Most small speakers, such as this, have a response that falls off at both the treble and bass ends of the range. The response may be improved considerably by adding a compensating network which attenuates the mid-range somewhat. Although such a network reduces the sensitivity of the speakers the quality of the sound is greatly improved. Loss of sensitivity means that the maximum sound output from the speakers is reduced, but on no account should the power rating of the speakers be exceeded in order to restore the same maximum level. The Philips speaker used has a power rating of 10 watts and, when fitted with the compensation network and driven from a 10 watt amplifier, the level of sound available will be found to be entirely adequate for the average lounge room.

CONSTRUCTION

The box is constructed from 13 mm particle board with simple butt joints. The dimensions shown in Fig. 1 are internal dimensions and allowance should be made for the thickness of the timber used. The box should be glued and screwed together with the front panel temporarily in position so that the box is held square. When the glue has thoroughly set sand the corners of the box to obtain a smooth surface and then cover the box with wood-grained contact paper. Allow sufficient width of contact paper so that it may be folded around the edges of the box onto the inner surface of the box. This will prevent the paper peeling off later as the edges will be preventing from lifting by the front and rear panels. Mount the speaker to the rear of the front panel and then cover the panel with speaker cloth or with any other material that is reasonably transparent to sound. Fit the front-panel assembly into position and then secure it by using thin nails through the front panel into the cleats. The heads of the nails may be hidden by punching them below the surface with a nail or centre punch.

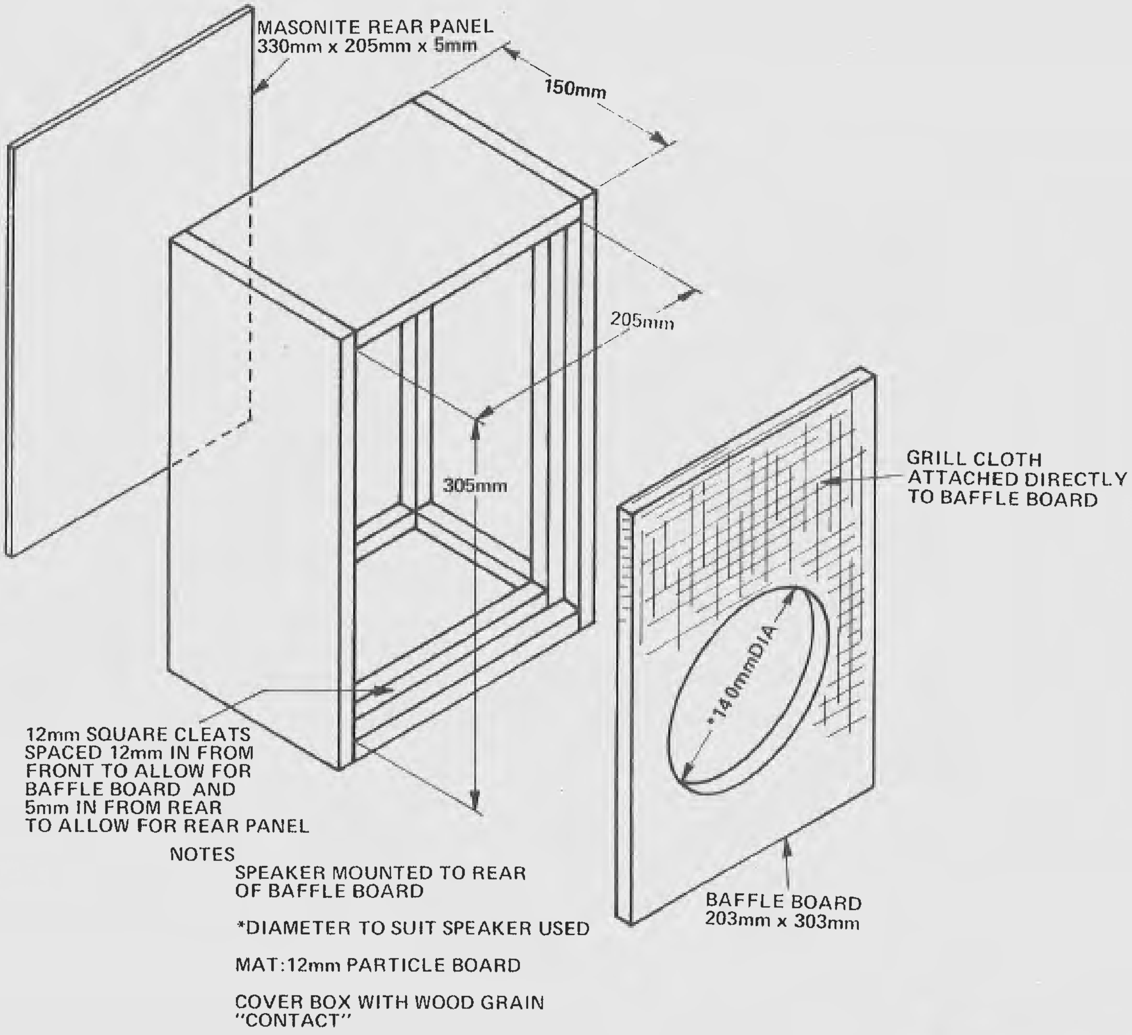
If the network is not being used then the speaker leads may be attached directly to the speaker (about two and a half metres of figure-8 flex is adequate), and passed out through a small hole in the masonite back panel. It is wise to secure the cable to the rear panel so that a pull on the cable will not damage the speaker. The rear panel may then be secured in position by four screws.

COMPENSATING NETWORK

The compensating network is mounted to the rear panel. The potentiometer is mounted directly into a hole in the panel and the choke is mounted by glueing it to the inside surface of the panel close to the position of the potentiometer. ,The bipolar electrolytic capacitor is mounted across the terminals of the potentiometer. The choke is also connected to the same points. The whole network is then placed in series with one of the leads to the speaker. Winding details of the choke are given in Table 1.

When listening to the speaker adjust the potentiometer for the most-level response from the speaker. Once adjusted you'll be amazed just how good this simple speaker system will sound.

Fig. 1. Dimensions of the speaker box.


MASONITE REAR PANEL
330mm x 205mm x 5mm
150mm
205mm
305mm
GRILL CLOTH ATTACHED DIRECTLY TO BAFFLE BOARD
*140mmDIA
12mm SQUARE CLEATS SPACED 12mm IN FROM FRONT TO ALLOW FOR BAFFLE BOARD AND 5mm IN FROM REAR TO ALLOW FOR REAR PANEL
NOTES
SPEAKER MOUNTED TO REAR OF BAFFLE BOARD
*DIAMETER TO SUIT SPEAKER USED
MAT:12mm PARTICLE BOARD
COVER BOX WITH WOOD GRAIN "CONTACT"
BAFFLE BOARD
203mm x 303mm

MAKING THE COIL

The 2 mH choke is most easily constructed by winding it on a Philips Elcoma P26 ferrite pot core. These P26 cores have different permeabilities which are marked on the core. Any of the types listed below may be used with the appropriate number of turns. Wire gauge is not critical. Anything over 0.4 mm, up to the maximum shown in the table may be used for any type core.

Do not use a bolt to hold the two halves of the cores rogether; use the Elcoma clip and then glue the completed coil into position.

TABLE 1

CORE TYPE	NO OF TURNS	MAX WIRE GAUGE
AL1600	20	1.0 mm
μE330 or AL1000	55	0.8 mm
μE220 or AL630	70	0.63 mm
AL400	70	0.63 mm
μE150	65	0.5 mm
μE100	80	0.5 mm
AL250	90	0.5 mm
μE68	95	0.5 mm
AL160	110	0.4 mm

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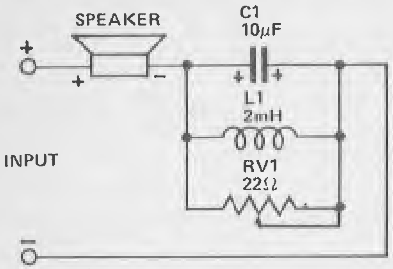
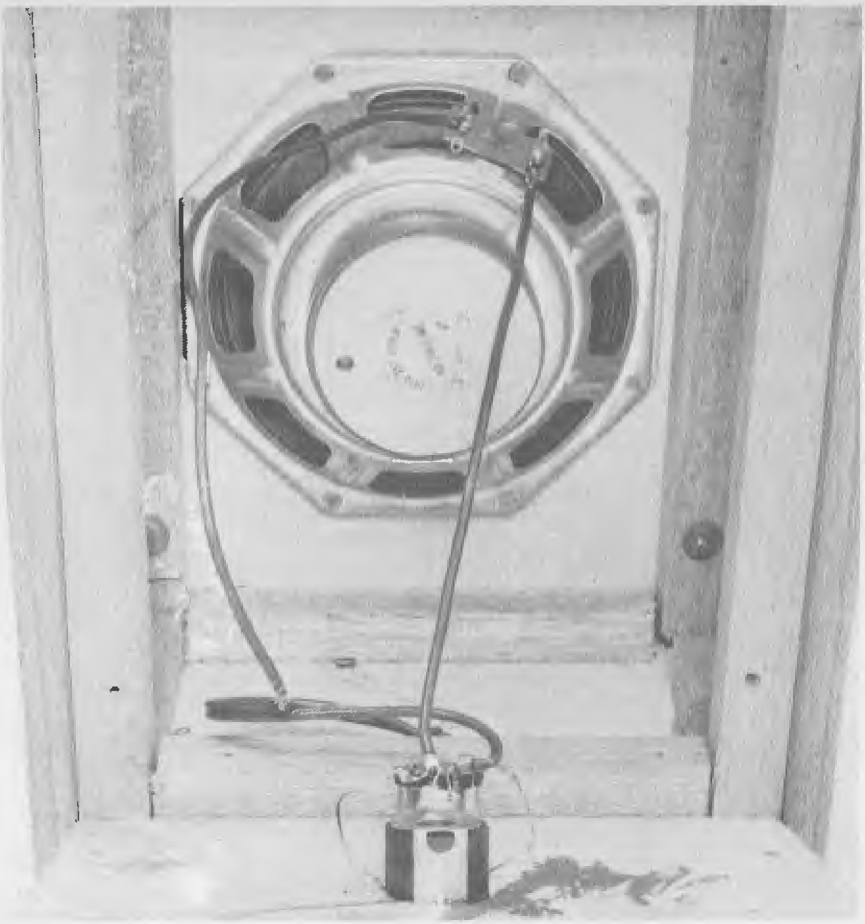


NOTE
RV1 MOUNTED THROUGH REAR PANEL

GLUE L1 ONTO REAR PANEL NEXT TO RV1 WITH EPOXY

Fig. 2. How the compensation network is connected. Note that capacitor C1 is a bipolar electrolytic, and RV1 has a minimum rating of 2 watts.

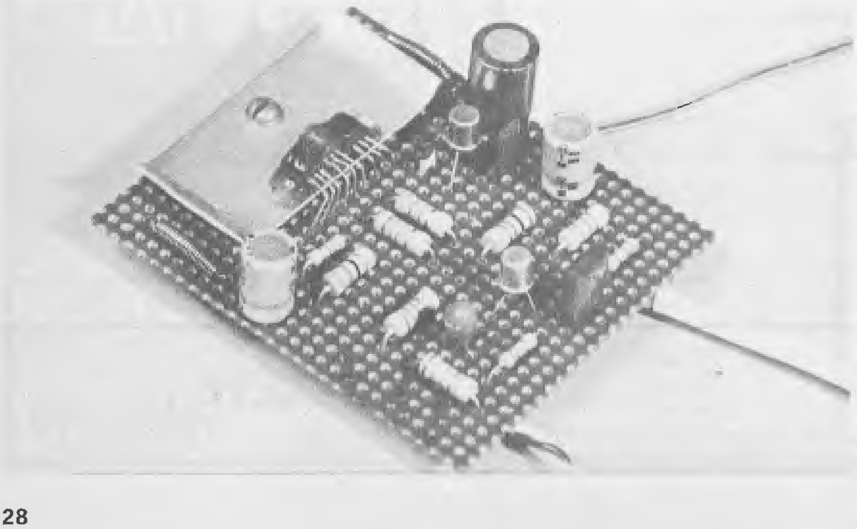


Internal view of the speaker. Note the compensation network mounted to the rear panel.

PROJECT
225

SIMPLE AMPLIFIER

Build ETI's cheap and simple 1.5 watt amplifier



The completed amplifier. Note the aluminium heatsink to which Q2, Q4 and Q5 are cemented. These transistors must be plastic TO92 types as per parts list.

AMPLIFIER ETI 225

A SMALL AMPLIFIER is an almost indispensible aid to the experimenter. It may be used to amplify, and make audible, signals from oscillators operating in the audio range, to trace signals through another audio amplifier that is faulty, to amplify any other signal to a reasonable power level for metering or relay operation etc etc.

There are at present on the market

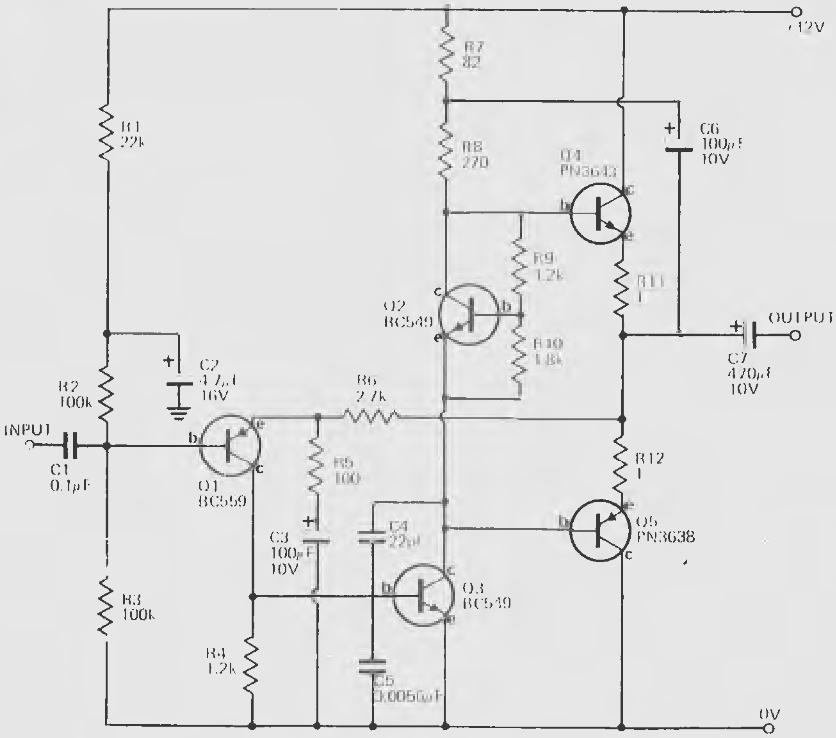
SIMPLE AMPLIFIER

many integrated circuit power amplifiers providing outputs of from 1 to 3 watts but most of them require very careful layout of the circuit in order to prevent instability (an unstable amplifier may oscillate and be damaged as a result) Additionally, a discrete transistor amplifier is far more educational in that voltages can be measured in order to gain a better understanding of its operation.

Hence the ETI 225 amplifier has been designed using discrete transistors which beside being much more stable than integrated designs, is ideally suited to the needs of the experimenter.

Transistors Q2, Q4 and Q5 are glued to a piece of aluminium which acts as a heat sink (use 5 minute epoxy). These transistors must be the plastic types specified. Metal can types usually have the collector connected to the case and would be shorted by the heat sink.

We have used a short section of an electric jug element to construct the one ohm resistors in the emitters of Q4 and Q5. However, one ohm, half watt resistors will be entirely suitable.



Circuit diagram of the 1.5 watt general purpose amplifier.

HOW IT WORKS ETI 225

This circuit is fairly typical of a large number of audio amplifiers.

The main voltage amplifier transistor Q3 drives the complementary pair (NPN plus PNP) Q4 and Q5 which are buffers providing high current gain but less than unity voltage gain.

As the bases of Q4 and Q5 are effectively two base emitter junctions apart, Q3 is used to set the bias voltages for these transistors.

Transistor Q1 operates as an error amplifier which compares the input voltage and a divided down version of the output voltage. If there is any difference it provides a control voltage to Q3 in such a way that the error is corrected. The output voltage is divided down by the ratio of (R6 + R5)/R5 and hence the calculated gain will be 28 although the measured gain will be slightly less.

The dc bias point of the amplifier is also set by Q2 and this is unaffected by R5 and it is isolated by means of C3. To maintain an approximately constant current in Q3, capacitor C6 is used to keep the voltage across R8 (and hence the current through it) constant.

Capacitors C4 and C5 are used to provide frequency compensation.

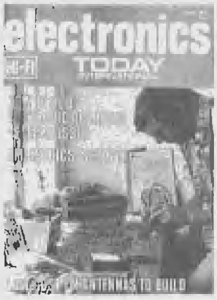
PARTS LIST
AMPLIFIER ETI 225

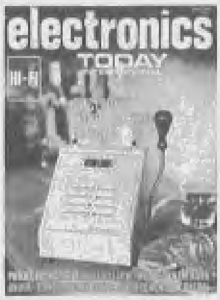
R11,12	Resistor	1Ω	½W 5%
R7	"	82Ω	" "
R5	"	100Ω	" "
R8	"	270Ω	" "
R4,R9	"	1.2 k	" "
R10	"	1.8 k	" "
R1	"	22 k	" "
R2,3	"	100 k	" "
C4	Capacitor	22pF ceramic	
C5	"	0.0056µF polyester	
C1	"	0.1µF polyester	
C2	"	4.7µF 16V electrolytic	
C3,6	"	100µF 10V electrolytic	
C7	"	470µF 10V electrolytic	
Q1	Transistor	BC559 or similar	
Q2,3*	"	BC549 or similar	
Q4*	"	PN3643 or similar	
Q5*	"	PN3638 or similar	

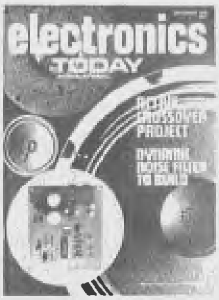
* must be TO92 plastic types.

piece of matrix board

piece of aluminium approx. 1" x ½" for heatsink.







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SIMPLE STEREO AMPLIFIER

PROJECT 429

Ideal beginner's amplifier suits simple record players.

THIS SIMPLE stereo amplifier uses two LM380 IC's and a minimum of external components, it can easily be assembled in only one or two evenings. It is designed to match the *crystal* cartridges found on most simple record players and gives surprisingly good results.

CONSTRUCTION

Check the orientation of the ICs on the PC board with the aid of the component overlay and solder them in position first of all. Next cut four heatsinks from shim copper or tinplate as illustrated in Fig. 3 (a rolled out tin can will do to make these).

Tin the tabs of the heatsinks and solder one to the centre three pins on either side of each IC.

Next mount the four diodes and the electrolytic capacitors, again checking orientation, as these devices are polarity conscious. Use shielded leads for the connections to the pickup cartridge and twisted pairs to the potentiometers.

Mounting position is not critical – a general rule of thumb is to keep input circuitry away from strong ac fields such as found close to power transformers and motors. Keep all leads reasonably short and away from moving parts likely to foul them. Additionally keep the power transformer well away from the pickup arm and its signal leads.

If you mount the volume and tone controls as we have, on a wood base board, solder an earth wire to the cases of the pots. This will stop the amplifier buzzing every time you adjust the controls. •

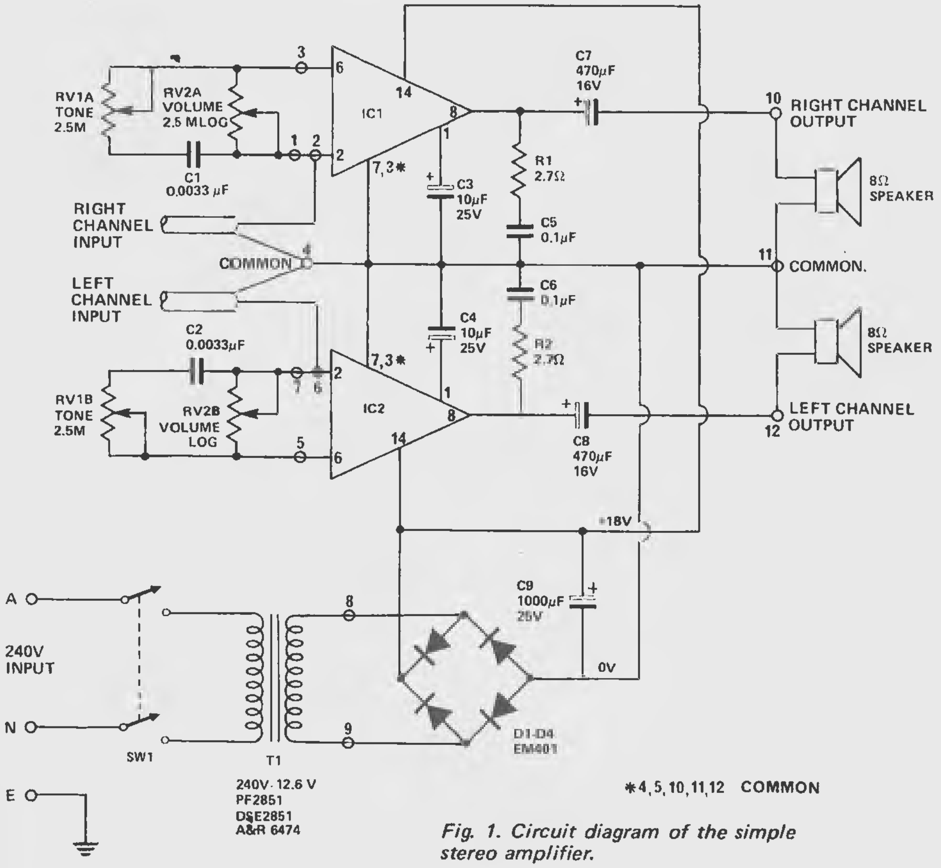
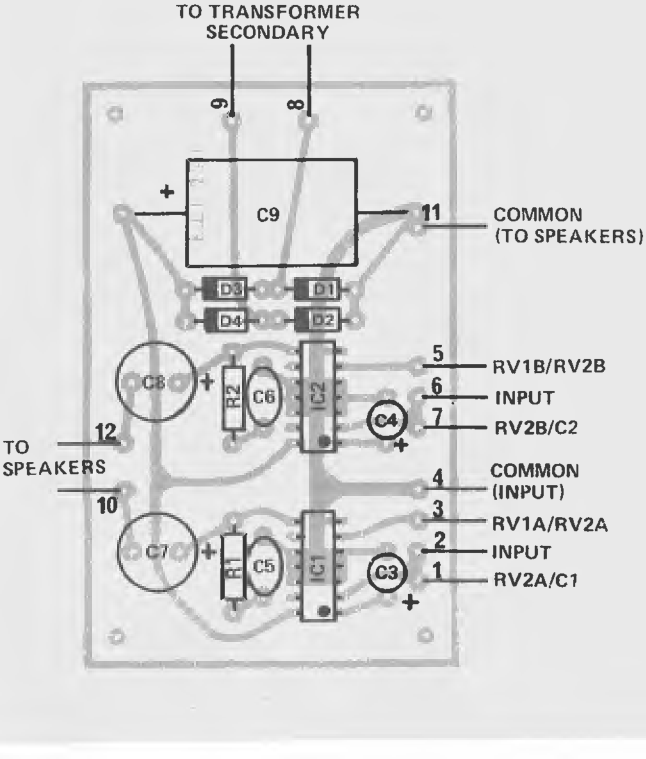


Fig. 1. Circuit diagram of the simple stereo amplifier.

Fig. 2. Component overlay.



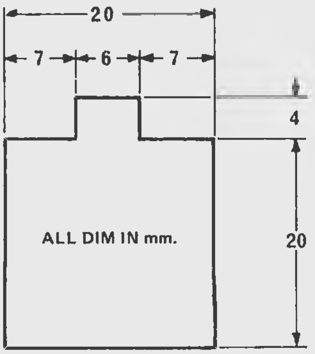


Fig. 3. Dimensions for the IC heatsinks. One is soldered to each side of the IC – to pins 3, 4, 5 and 10, 11, 12.

SPECIFICATIONS ETI 429

Input Sensitivity	200 mV
Input Impedance	150 k
Output power	2.5 W RMS / channel
Distortion	0.2%
Bandwidth	100 kHz (tone control flat)
Loudspeaker impedance	8 ohm or 15 ohm

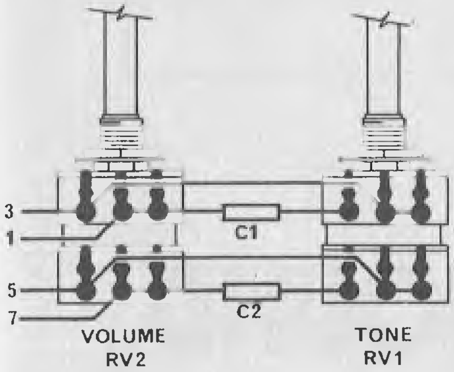
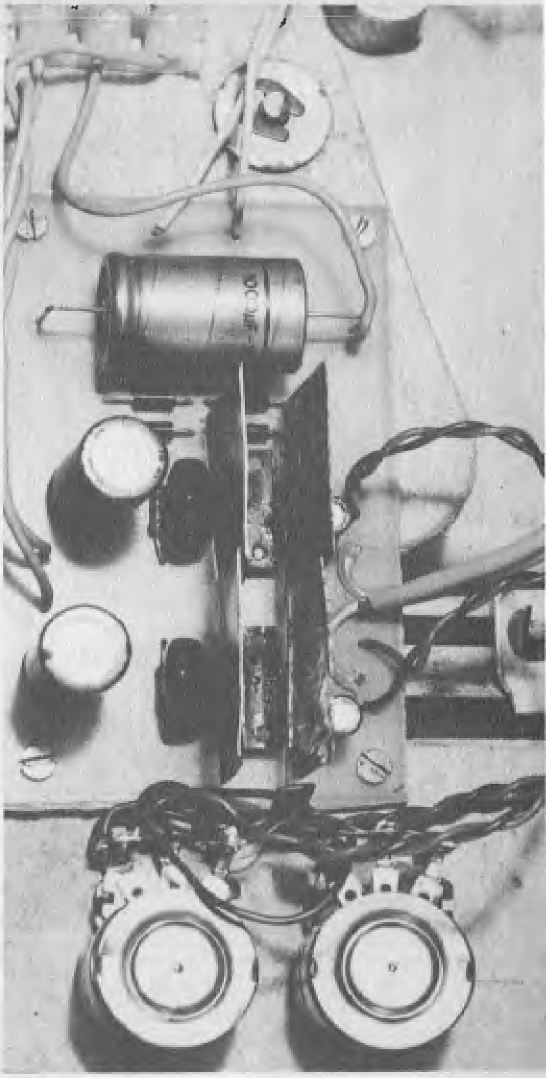


Fig. 4. Wiring to the volume and tone potentiometers.

PARTS LIST ETI 429

R1,R2	Resistor	2.7Ω ½W, 10%
C1,C2	Capacitor	0.0033μF, green cap
C3,C4	"	10μF, 25V electrolytic
C5,C6	"	0.1μF, green cap
C7,C8	"	470μF, 16V electrolytic
C9	"	1000μF, 25V electrolytic
D1,2,3,4	Diode	EM 401
RV1	Potentiometer	2.5 M LIN Dual
RV2	"	2.5 M LOG Dual
T1	Transformer	240V—12.6V, 0.15A PF2851, A&R 6474, DSE2851 or similar
SW1	Switch	DPST 2A 240V
PCB ETI 429		

Three core mains flex and plug, speakers (8-15 ohm), hookup wire, knobs, 3 way mains terminal strip.



The completed amplifier fitted below a conventional record player. Transformer (not shown) is mounted well clear of signal leads.

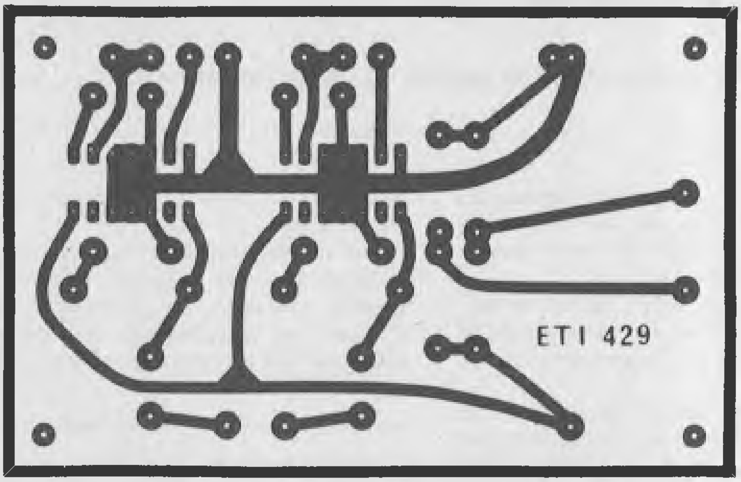


Fig. 5. Printed circuit board. Full size 97 x 61mm.

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470/25V .... 59c   220/25V 54c

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47µF/50V ... 34c   470µF/25V .. 60c
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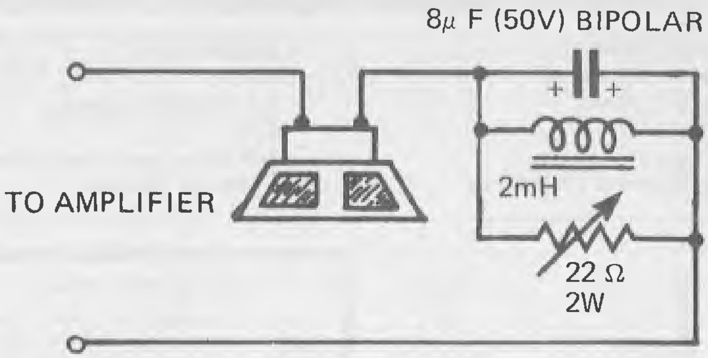

BETTER SOUND FOR $5

A dramatic improvement in speaker response for under $5!

Economy loudspeaker enclosures often contain just one wide range drive unit — usually of five inches or more in diameter.

Such speakers often sound 'peaky' due to the drive unit's characteristic of having too much output around 1000Hz.

A really dramatic improvement can be effected simply by wiring a choke/capacitor combination in series with the speaker.

This removes a lot of the energy around 1000Hz. The choke/capacitor combination is then bridged with a 25ohm potentiometer to bring some of the response back up.

The net result is a 6dB to 10dB decrease in that region, and what was previously a closed-in honky little sound now becomes a big spread-out spacious sound.

Losses in the network will decrease the speaker's efficiency — meaning that you will have to turn the volume control up a bit, but most amplifiers can easily provide the extra power required.

Figure 1 shows how the components are connected into circuit. The various bits may be built into the speaker enclosure — or even located alongside the amplifier. Once set, the potentiometer will not require subsequent adjustment.

The potentiometer is set merely by listening to some of your favourite music and choosing the setting you prefer best.

This simple modification can be used to advantage with any single drive unit speaker enclosure. It is perhaps the simplest and cheapest way to improve response that you can ever make. ●

This extraordinarily simple, yet effective modification, was recently suggested by Henry Kloss, now President of the Advent Corporation.

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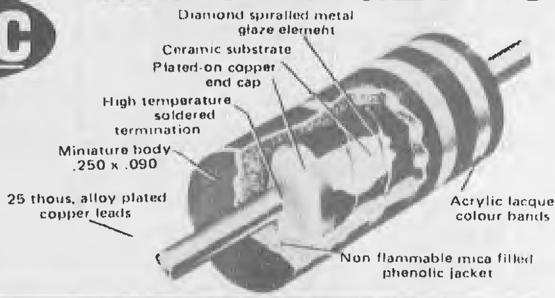
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Acrylic lacquer colour bands
Non flammable mica filled phenolic jacket

½ watt @ 70° C .250″ x .090″
Miniature Body Size

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Plus! Fully Insulated Non-flammable Mica Filled Phenolic Jacket
Result! THE SAFE ONE

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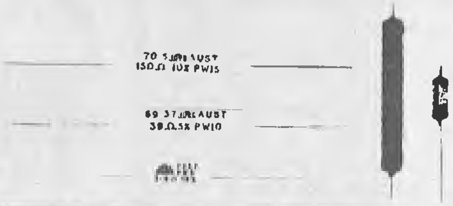

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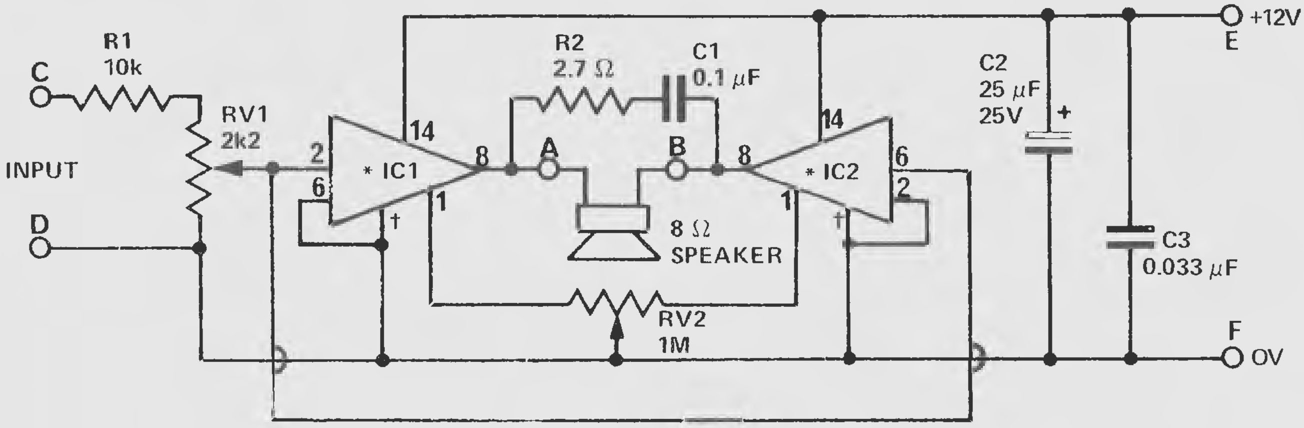


*IC1, IC2 LM380
† PIN 3, 4,5,7,10,11,12

Fig. 1. Circuit diagram of the booster amplifier.

MOST portable radios and cassette players have a power output which seldom exceeds 100 milliwatts. Whilst this is entirely adequate for normal listening, many people find that it is entirely inadequate when such equipment is used in a car. There the extremely high noise level effectively drowns out such radios and one is left with the choice of buying a proper (and quite expensive) car radio, or, of forgetting about the whole deal.

However this problem can be overcome by using a small booster-amplifier to provide the additional power required. Such an amplifier should be powered from the 12 volt car supply and should accept an input from the earphone, or external speaker socket of the radio or cassette player.

The ETI booster amplifier has been designed to suit such applications and uses the inexpensive LM380 ICs. Two ICs are connected in a bridge arrangement which provides an output of around five watts RMS (12 volt supply and 8 ohm speaker). The amplifier may be used to drive an eight-ohm speaker permanently mounted in a suitable position in the car.

CONSTRUCTION

The components should all be mounted on a small printed circuit board (or Veroboard etc) as shown in the component overlay diagram. If Veroboard construction is used it is preferable to mount the ICs, in line, such that a common heatsink may be attached to both ICs on each side. Each heatsink should be at least 25x50mm and be constructed from copper or tin plate.

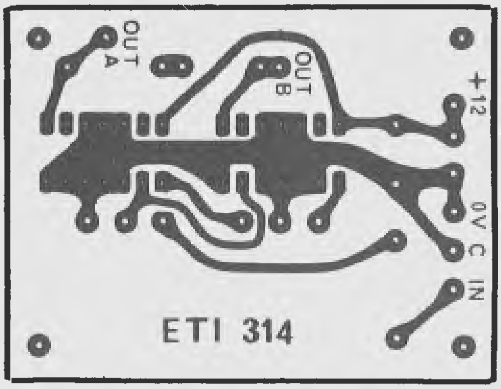


Fig. 2. Printed circuit board. Full size 50 x 65 mm.

Two preset potentiometers are provided for setting up the amplifier. The preset-volume potentiometer, RV1 should be adjusted to suit the output voltage available from the radio or cassette. Sensitivity of the booster is such that 5 watts output will be obtained (with RV1 at maximum sensitivity) with an input of 50 mV. This should be entirely adequate as most radios will provide in excess of 200 millivolts.

The balance potentiometer should be set for minimum dc through the speaker as detailed in the 'How It Works' section.

The compactness and simplicity of the amplifier enable it to be mounted in any convenient position, eg, even on the rear of the speaker itself! However, care should be taken to position it such that mechanical damage is unlikely to occur, and that adequate ventilation of the heatsink is obtained.

PARTS LIST ETI 314

* R1	Resistor	10k ½W 5%
R2	"	2.7 ohm ½W 5%
* RV1	Potentiometer	2k2 Trim
RV2	"	1M Trim
C1	Capacitor	0.1µF polyester
C2	"	25µF 25V electro
C3	"	0.033µF polyester

IC1, IC2 Integrated Circuit LM380
PC Board ETI 314

* The value of these components may vary for different input requirements.

HOW IT WORKS – ETI 314

The LM380 is an integrated audio amplifier which has a fixed gain of 50 dB and can be connected in either inverting or non-inverting mode (ie output 'out of phase' or 'in phase' with the input respectively).

Two of these ICs have been used in a bridge arrangement which allows a higher power output to be obtained with the low supply voltage (12 volts) available from the car. To do this we drive both amplifiers with the same signal, but connect one for inverting, and the other for non-inverting mode. The speaker is now connected between them and thus receives twice the output voltage that would be available from a single IC.

The input required for full power output is about 50 millivolts. Hence we have provided an input attenuator to increase the input requirement to about one volt which will enable preset adjustment to suit most radios or cassettes.

We used a trim potentiometer on the board to adjust sensitivity such that full volume is obtained with the volume control of the source about half way up. If desired, a separate potentiometer may be used in place of the preset as a volume control.

Output voltage of the ICs is about half of the supply. However since the speaker is direct coupled, any slight difference in amplifier outputs will result in a dc current flow through the speaker. Potentiometer RV2 should be adjusted, with the aid of a multimeter, for zero volts across the speaker (or minimum current from the supply). Alternatively, if a multimeter is not available, make and break one speaker connection and adjust RV2 for minimum 'clicking' sound from the speaker.

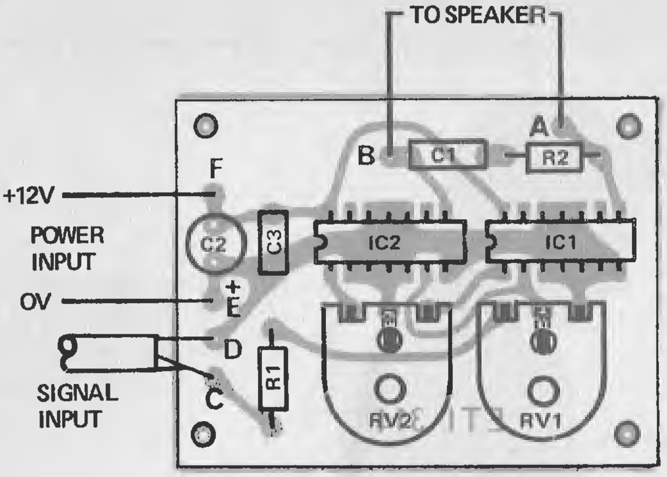


Fig. 3. Component overlay.

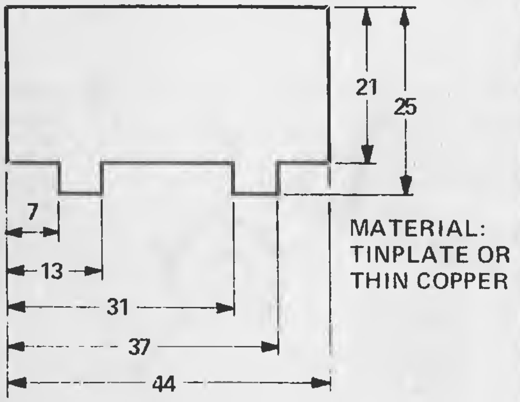
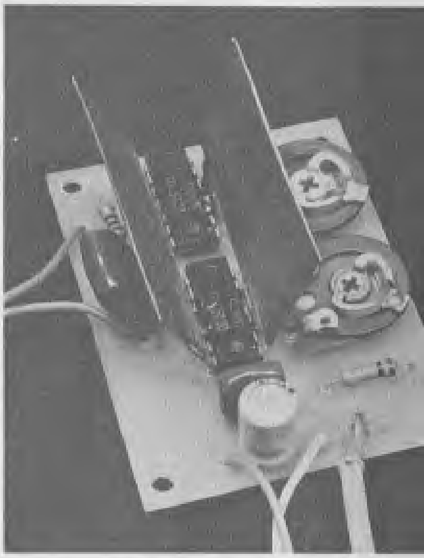


Fig. 4. Heatsink (two required) to be attached to either side of both IC's as shown in main picture.



BATTERY TRAP

When soldering leads to AA size cells (the size used in pen torches) it is most important to remove the metal disc at the bottom of the cell, and solder directly on to the zinc case. These cells are designed to be used under compression, by the spring in a torch, and they depend on the compression to ensure good contact between the metal disc and the cell itself. Without the pressure – such as when a cell is soldered into circuit, it's easy to get a very poor contact or an actual open circuit

A.J. Lowe

SPECIFICATION

POWER OUTPUT		
12.6 volt supply 8 ohm load		5 watts
DISTORTION		
12.6 volt, 8 ohm, 1 kHz		
at 5 watts		3%
at 3 watts		0.5%
SUPPLY VOLTAGE		
Nominal		12 volts
MAX SUPPLY VOLTS		
	Speaker load	
LM380	8	15 volts
	16	22 volts
SPEAKER IMPEDANCE		> 7 ohms
FREQUENCY RESPONSE		
10 Hz – 100 kHz		$\pm^{0}_{3}$ dB
SENSITIVITY		
Maximum (no input attenuator) into 75 k ohm		50 mV

Which man are you?

Today's electronic equipment varies widely in its sophistication, and in the demands it makes . . . on soldering equipment, and the man who uses it. Which man are you?

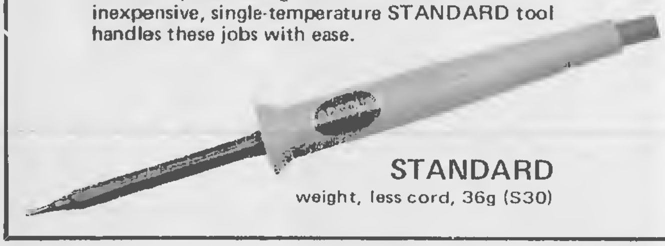
■ Involved with COMPLEX OR SENSITIVE CIRCUITRY?
Sophisticated solid state components, multi-layer and high density circuitry as found in colour TV, industrial instrumentation etc. need the controlled temperature, slim profile and high power of the mains voltage THERMATIC.

THERMATIC
In-handle temperature control and selection.
weight, less cord, 40g (T30)

■ Handle GENERAL ELECTRONIC EQUIPMENT?
Radio, stereo, black and white TV service, and general commercial electronics work require fast heat-up and maximum versatility. The DUOTEMP idles at soldering temperature, and doubles its power for heavy or sequence soldering.

DUOTEMP
Push button control doubles thermal power
weight, less cord, 40g (D30)

■ Keen on HOBBIES & HANDYMAN JOBS?
For broken toys, appliances, automotive wiring, door chimes, jewellery, and a hundred jobs around the home, a soldering tool is a must. The inexpensive, single-temperature STANDARD tool handles these jobs with ease.



STANDARD
weight, less cord, 36g (S30)

■ Responsible for HIGH RELIABILITY EQUIPMENT?
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ECT SOLDERING STATIONS provide extremely accurate temperature from direct reading control: low voltage for safety: zero tip potential.
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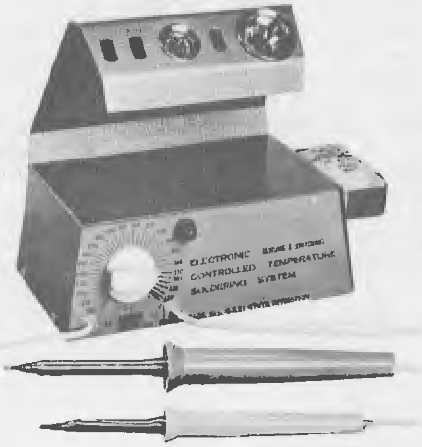

ECT 6724
SOLDERING STATION
CT7 tool: weight less cord 50g
CT6 tool: weight less cord 23g

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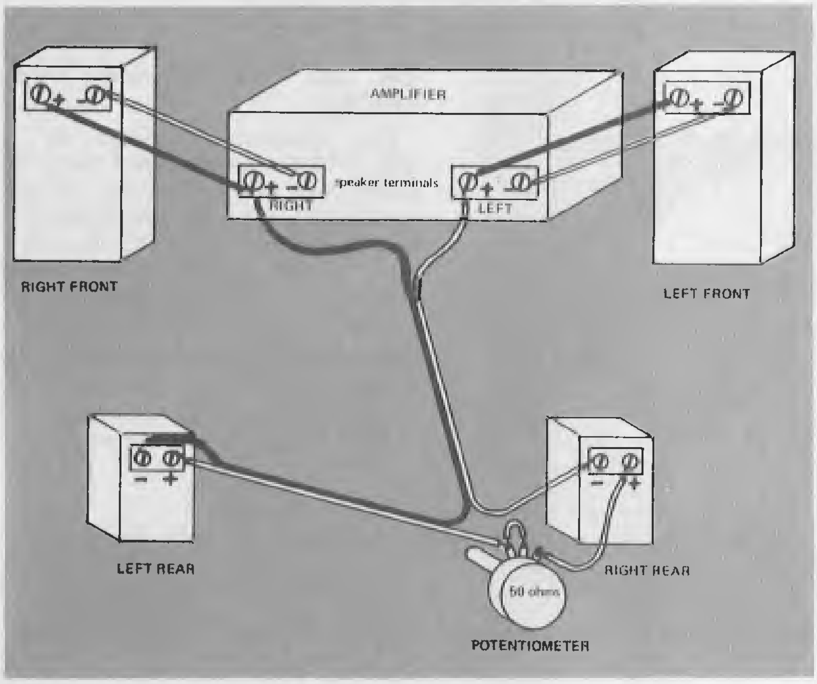


Fig. 1. How the connections are made. Note that all the speakers and the amplifier are shown as seen from the rear.

PROJECT 402

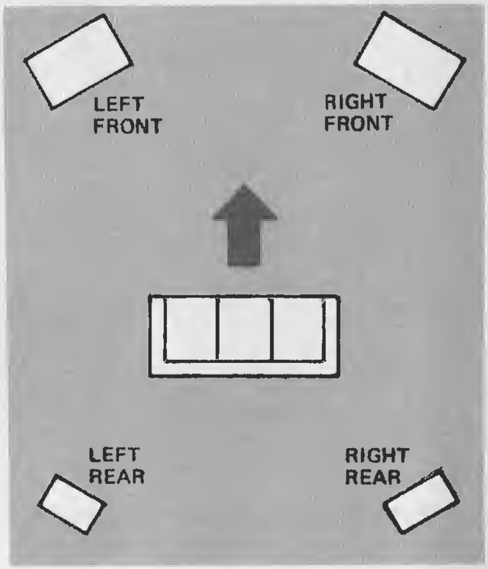


Fig.2. How the speakers are positioned.

DESPITE enormous promotion, commercial four-channel sound has not, so far, been the success that many had forecast.

There are two main competitive and totally non-compatible systems. These are known as discrete and matrix respectively.

Discrete systems utilise very special records or tapes onto which are encoded the four separate recording tracks. A very sophisticated decoder built into the reproducing equipment then decodes the four channels and directs each of the resultant four sound channels to the required loudspeaker. Discrete sound is very effective but hideously expensive — and so far at least some discrete records have had a very short playing life.

Matrix systems are far simpler. The original four channels are 'mixed together' and recorded on a conventional record or tape. Decoders built into the reproducing equipment then 'unmix' the four channels and more or less route the required sound to the relevant speaker. Matrix systems are not as effective as discrete systems but are generally cheaper. They have however the big advantage that they can synthesize 'four-channel' sound from normal two-channel stereo recordings.

Some commercial equipment has a matrix decoder built in. Other relatively sophisticated units can be obtained as add-on items. However even matrix decoders are expensive devices — and many purchasers may not feel they are worth the price.

Here then is a very simple decoder. It has been published before — in fact ETI ran it way back in 1971. But it's still the simplest way to find out what four-channel matrix sound is all about — and in many people's experience it performs at least as well as the $100 plus commercial units.

The rear speakers don't need to be anything special, in fact best results will be obtained from units with restricted treble response — if you're using existing speakers it may be best to disconnect the tweeters. Virtually *any* speakers will do.

The potentiometer should preferably be a two watt unit — if you can't locate one readily then a one watt unit will do.

Adjust the system by playing a classical symphonic recording — preferably one that has been recorded 'live'.

Set the potentiometer so that sound is only just discernible from the rear channels. ●

HOW IT WORKS

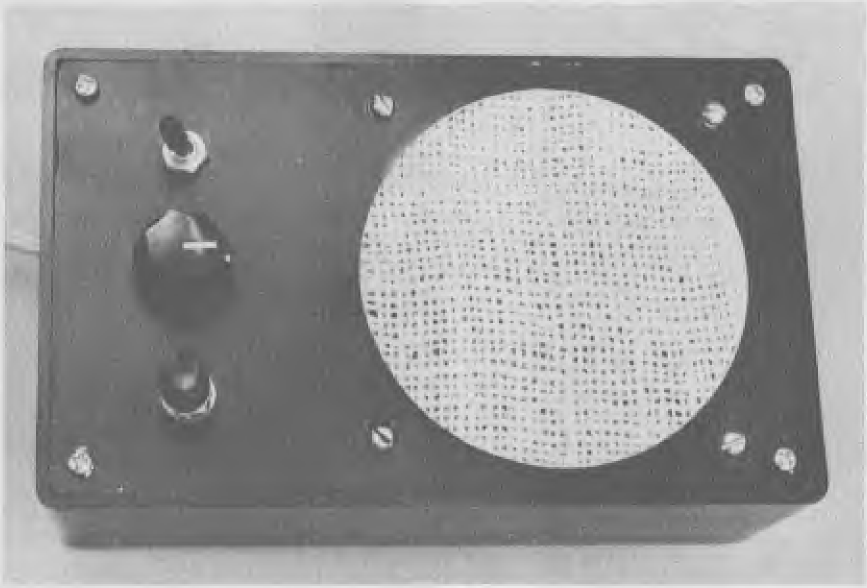
When a normal stereo record is made in a concert hall, a great deal of reverberant sound is masked by the direct sound from the performers. Nevertheless reverberant sound is right there on the record. All we have to do is extract it.

Our simple decoder does just that. It works by extracting signals which are the *difference* between the right hand and left hand programme channels.

It works best on recordings that have been made 'live' – particularly classical recordings. It will not be effective on records made in dead surroundings – nor on some pop records in which all instruments have been wired directly into the recording mixer.

PROJECT 234

SIMPLE INTERCOMS



Three intercom systems using the LM380 audio IC.

AN INTERCOM SYSTEM is not only one of the most useful projects that one can build, it is also one of the easiest.

Commercial intercoms are of course readily available – often at prices even lower than one could build the units for oneself. Nevertheless a project of this nature is still more than justifiable for not only does it provide valuable experience but the system can also be built to suit one's exact needs.

In the ETI unit, as with most simple intercoms, a speaker doubles as both microphone and loudspeaker, its role being changed from one to the other by a pushbutton 'talk/listen' switch.

As a loudspeaker is not particularly efficient when used as a microphone, we have used a step-up transformer and LM 380 integrated circuit amplifier.

The transformer chosen is a 240 V/12.6 V centre-tapped device (of which only one half of the primary winding is used). The specification of this transformer is not at all critical and virtually any device having roughly the specified characteristics will do.

Whilst the circuit of a suitable power supply is shown (Fig. 4) current drain is low and battery operation may be used if the unit is not used very much.

CONSTRUCTION

Construction is very simple indeed and, as there are very few components, we suggest that the amplifier be built onto matrix board or similar. A heatsink is not required for the LM380, when working into a 15 ohm, be sure to obtain speakers having this impedance. Higher impedances will result in much lower power output, and lower impedance speakers (eg 8 ohms) will require the use of a heatsink.

The internal layout of the prototype unit is shown in Fig. 5. Note that we used the system connections shown in Fig. 2. This system requires (easily obtainable) single-pole push buttons but requires three interconnecting wires between station 1 and station 2. It also has the advantage that an

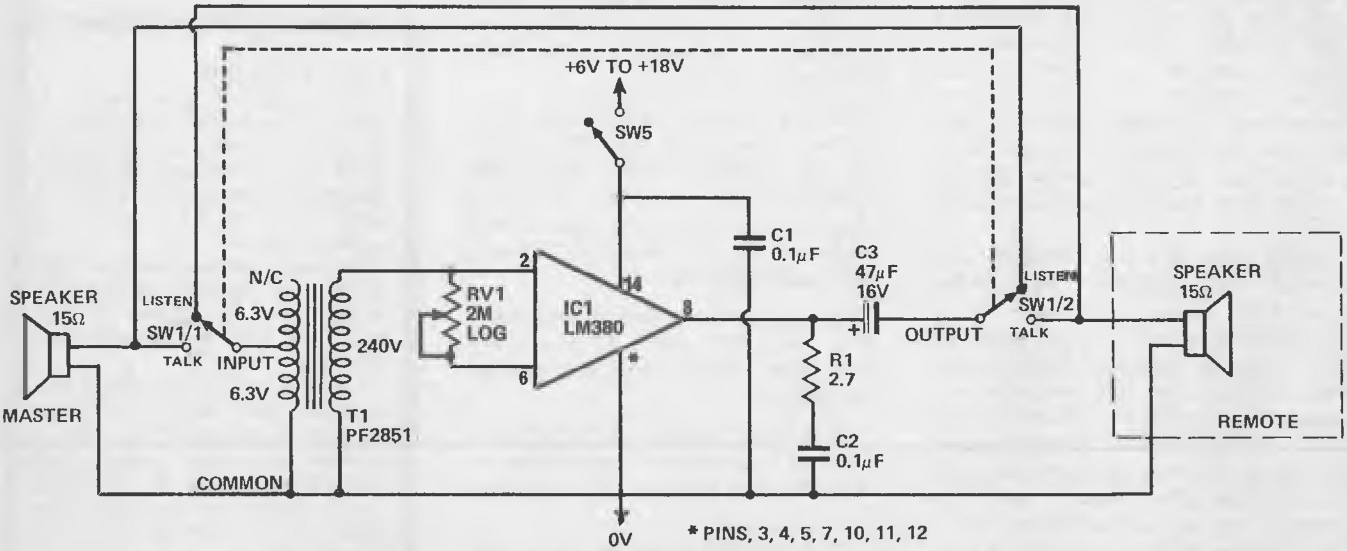


Fig. 1. About the simplest possible intercom, in this arrangement the master station listens to remote station at all times until TALK button is pressed.

output is heard only when the TALK button at either station is pressed.

The system shown in Fig. 1 only requires two wires to the remote station but has the disadvantage that station 1 is always listening to station 2 except when the talk button is pressed.

If two remote stations are required the system illustrated in Fig. 3 should be used. Again this requires three wires to each of the remote stations. Switch SW1 is the push-to-talk button and SW2 selects the required remote station.

We used a small 9 volt battery to power our unit but, if continuous use is expected, it would be wiser to use a larger battery. For example, the standby current is about 3 mA which would result in only about 150 hours operation from a small battery. The best battery system would probably be two 6 volt lantern batteries connected in series. Alternatively a simple power supply such as shown in Fig. 4 could be used. ▶

HOW IT WORKS ETI 234

The (approximately) 1 millivolt output from the speaker is stepped up by transformer T1. The transformer is a standard 240/12.6 CT type used in reverse, only half of the 12.6 volt winding is used. Alternatively either of the A&R audio transformers, as specified in the parts list could be used.

The output of T1 is connected directly to the non-inverting (+) input of the LM380 (pin 2) and also, via potentiometer RV1, to the (–) input. Since the input resistance of the IC is about 150 k, the signal level at the negative input is dependant upon the setting of RV1.

The IC, as with all differential amplifiers, amplifies the *difference* in signal level between its two inputs, pins 2 and 6. Thus RV1 effectively acts as a volume control.

With the connections shown on Fig. 1, the remote station speaker acts as a microphone, applying its output to T1. The output of T1 is amplified by the IC and applied to the MASTER speaker. Thus the master station is listening to the remote station at all times other than when SW1 is pressed.

When SW1 is pressed the master speaker becomes the microphone and the remote speaker receives the amplified signal from the IC.

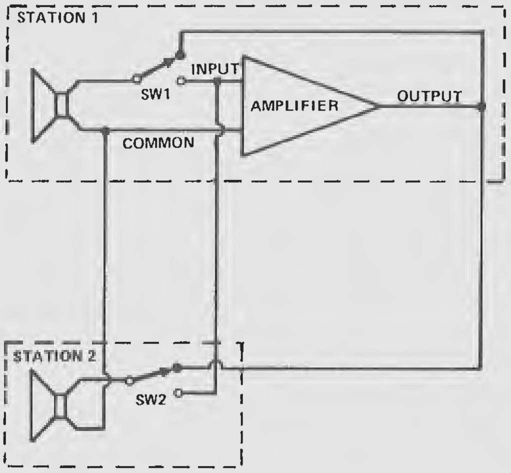


Fig. 2. This system gives privacy to station 2 but requires three wires between stations. The amplifier circuit is identical to that in Fig. 1.

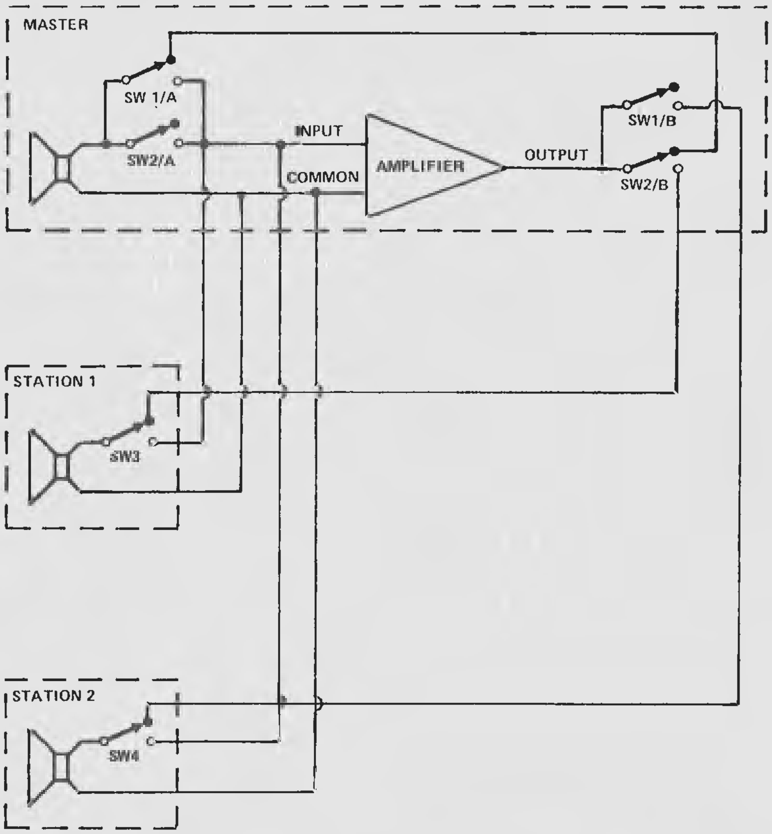


Fig.3. An extension of the previous system to a master and two slaves requires three wires from the master to each slave, and a more complex switching arrangement.

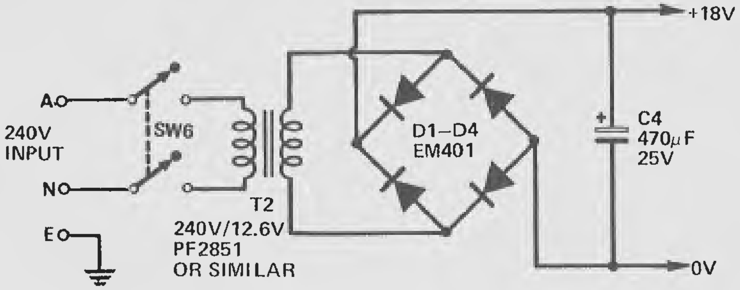


Fig. 4. A simple power supply for use with the intercom.

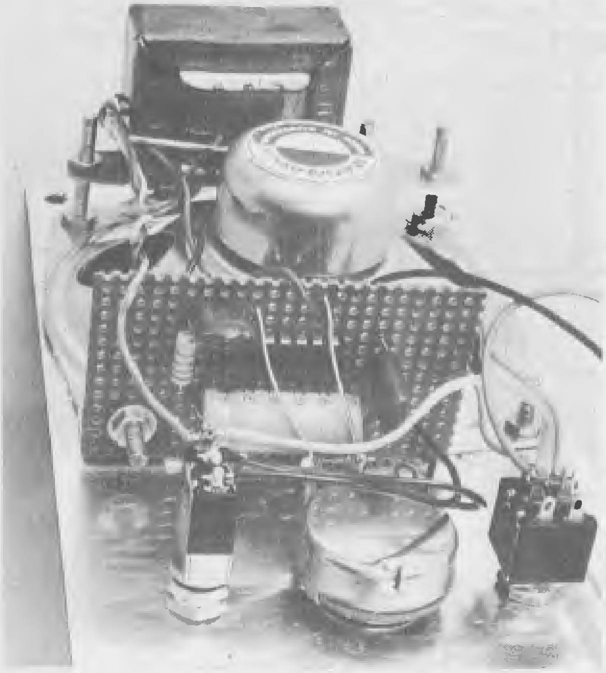


Fig. 5. The method of assembly may readily be seen from this internal view.

Parts List

R1	Resistor	2.7 ohm ½ watt 5%
C1, C2,	Capacitor	0.1µF polyester
C3		47µF 16 volt-electrolytic
IC1	Integrated circuit	LM380
T1	Transformer	240/12.6 volt centre tapped Ferguson type 2851 A & R type 6474 A & R E7/3.5 or E5/3.5 (or any 240/6.3 volt transformer you may have)
RV1	Potentiometer	2M log rotary

	System 1	System 2	System 3
SW1	DPDT pushbutton	SPDT pushbutton	DPDT pushbutton
SW2	—	SPDT pushbutton	DPDT pushbutton
SW3	—	—	SPDT pushbutton
SW4	—	—	SPDT pushbutton
SW5*	SPDT toggle	SPST toggle	SPST toggle

Loudspeakers 15 ohm 3" diameter Magnavox 3T or similar.
Six to 12 volt battery. *
Plastic or metal box, piece of matrix board, bolts and nuts etc.
* required for battery versions only.

Power Supply

D1-D4	Diode	EM401 or similar
C4	Capacitor	470µF 25 volt electrolytic
C5	Capacitor	25µF 25 volt electrolytic
T2	Transformer	240/12.6 volt CT Ferguson PF 2851, A & R 6474 or similar
SW6	Switch	DPST toggle 240 volt ac 1 amp.

---

eti PROJECT 218

MONOPHONIC ORGAN

This miniature organ has full two-octave range — plus tremolo.

The completed organ (not mounted in a case) together with its probe. We used a conventional phone jack as the probe.

You may well have seen Rolf Harris, on his TV show, playing a small hand held organ, the notes being selected by a metal probe. Such an organ (known as a monophonic organ because only one note can be played at a time) can be very effective indeed especially when well tuned and fitted with tremolo.

The ETI organ is such an instrument, it is capable of producing a very fine sound, and should provide a great deal of musical enjoyment — as well as being electronically educational.

Because this is likely to be built as a permanent device we have designed a printed circuit board for this project. This will familiarize the builder with the advantages of using a printed circuit board (neatness, ease of

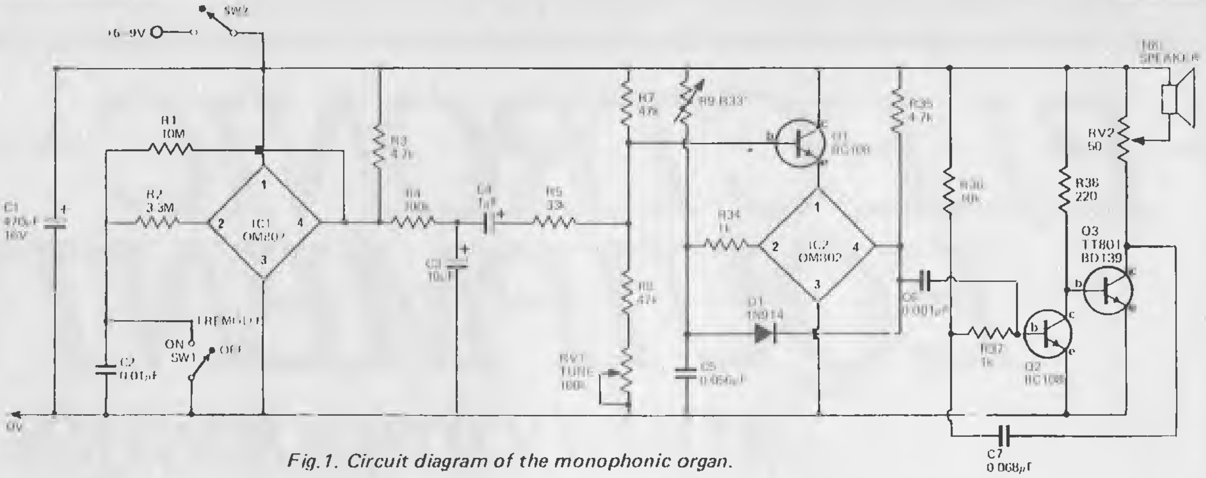


Fig.1. Circuit diagram of the monophonic organ.

construction etc). Additionally, in this case the printed circuit board offers an ideal solution to the problem of building a keyboard. The keyboard is simply etched onto the printed circuit board! As copper rapidly oxidizes when touched (resulting in high contact resistance), the board should be gold flashed or roll tinned to ensure good keyboard operation — ensure that this has been done when purchasing.

The instrument provides a full two-octave range including sharps and flats. We have selected the octaves from C (262 Hz) to C (1047 Hz) but other octaves may be obtained if required by changing the value of C5.

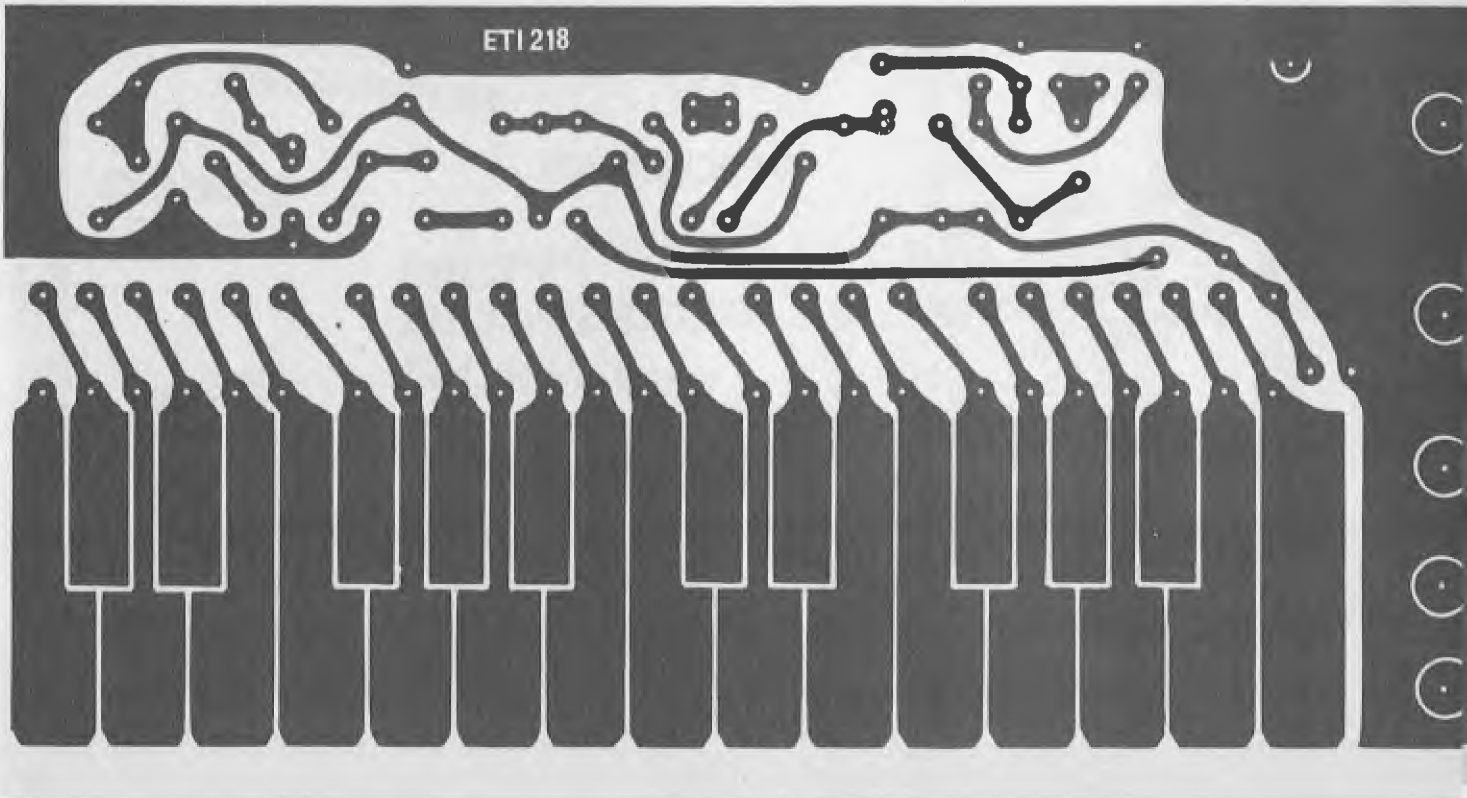
PARTS LIST
ORGAN ETI 218

R38	Resistor	220Ω	½W	5%
R34,37	"	1 k	"	"
R10	"	3.3 k	"	"
R11	"	3.6 k	"	"
R12,13	"	3.9 k	"	"
R14,15	"	4.3 k	"	"
R3,16,35	"	4.7 k	"	"
R17	"	5.1 k	"	"
R18,19	"	5.6 k	"	"
R20,21	"	6.2 k	"	"
R22	"	6.8 k	"	"
R23,24	"	7.5 k	"	"
R25,26	"	8.2 k	"	"
R27 28	"	9.1 k	"	"
R36	"	10 k	"	"
R29,30,31	"	11 k	"	"
R32	"	12 k	"	"
R33	"	13 k	"	"
R5	"	33 k	"	"
R7,8	"	47 k	"	"
R9	"	56 k	"	"
R4	"	100 k	"	"
R2	"	3.3 M	"	"
R1	"	10 M	"	"

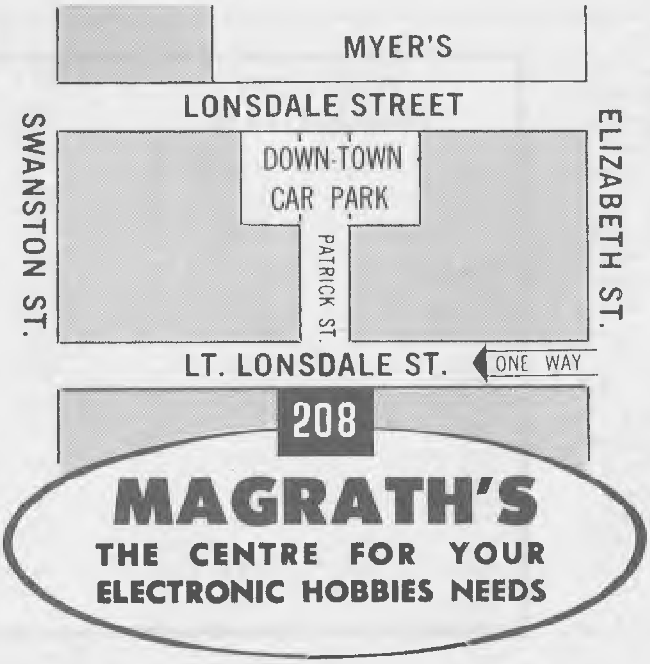
RV1	Potentiometer	100 k lin rotary
RV2	"	50Ω 1W rotary
C6	Capacitor	0.001µF polyester
C2	"	0.01µF polyester
C5	"	0.056µF "
C7	"	0.068µF "
C4	"	1µF 35V electrolytic
C3	"	10µF 16V electrolytic
C1	"	470µF 16V electrolytic
IC1,2	Integrated circuit	OM802
Q1,2	Transistor	BC108 or similar
Q3	"	TT801, BD139 or similar
D1	Diode	IN914
16Ω	Speaker	
SW1	Single pole ON-OFF switch	
SW2	Single pole ON-OFF switch	

PC Board ETI 218 gold flashed or roll tinned.

Fig.2. Printed circuit board layout for the monophonic organ (full size).



ELECTRONIC EQUIPMENT
and components



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MONOPHONIC ORGAN

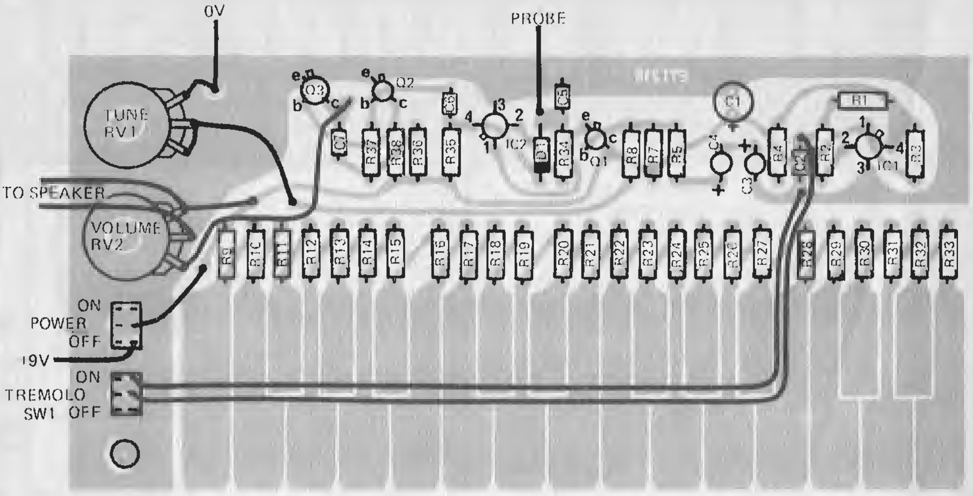

Fig.3. Component overlay shows positions of the components on the board. Watch polarities of capacitors, transistors etc.

HOW IT WORKS
MONOPHONIC ORGAN ETI 218

The heart of the organ is the integrated circuit type OM802. This is an oscillator that operates in a very similar manner to that using a unijunction transistor.

With reference to the circuit diagram, and in particular to ICI, we have the initial situation where C2 is discharged and the output voltage of the IC (at pin 4) is high at approximately 6 volts. In this condition the current into the input (pin 2) is virtually zero and hence C2 will begin to charge via R1.

When the voltage at pin 2 of the IC reaches approximately 50% of the supply voltage, both the output voltage, and the voltage at pin 2 will drop to near zero. This causes C2 to be discharged through R1 as well as through R2. When the voltage across C2 falls to less than 1 volt the output again reverts to the high state, the input current falls to zero and C2 begins to charge again.

The mark/space ratio of the cycle can be varied by changing the ratio of R1 and R2. With the values given, the mark/space ratio is 1:1 and the frequency about 10 Hz. The output is filtered by R4 and C3 to provide a waveform that is used to modulate the tone oscillator producing a pleasing variation of the basic tone. This is known as tremolo.

The tone generator (IC2), works in a similar fashion to IC1, however the supply voltage to the IC is varied through Q1 by means of the tune control (RV1) as well as by the tremolo input.

In this case C5 is the basic charging capacitor and the charging resistance (R9-R33) is selected by probing the keyboard. In the charging cycle in this instance the charging current is not removed when the threshold voltage is reached, but instead the capacitor is rapidly discharged by diode D1. Using this method, the output is low for a period of only 10 microseconds.

The resistors R9 to R33 are chosen such that the notes are a semitone apart that is, the ratio of the two notes is $\sqrt[12]{2}:1$. Transistors Q2 and Q3 form a monostable which provides, when triggered, a pulse with a duration of 0.5 milliseconds. In the rest condition Q2 is on and Q3 off. The negative pulse from IC2 is coupled to the base of Q2 via C6 and momentarily turns Q2 off and Q3 on. Capacitor C7 couples this negative going transition into the base of Q2 holding it off for about 0.5 milliseconds whilst C7 charges up via R36. The positive pulse from IC2, which occurs 10 microseconds after the negative transition, is swamped by the much higher energy input from C7.

Potentiometer RV2 adjusts the output to the speaker from the monostable.

FINISHING FRONT PANELS

THE FINISH on aluminium panels can be improved by etching them in a caustic soda solution. To get the best effect:

1) Do all marking out on the back of the panel.

2) Drill holes two ways — small pilot hole from front to back. This minimises the problem of getting rid of the 'flash' which arises round the holes while drilling. Removing flash often leaves scratches, and it is better that these be on the back of the panel than the front.

3) Rub the front of the panel with medium grade emery cloth to rid it of all unwanted marks and scratches. The emery should be rubbed only in one direction for the final rubbing. This leaves the aluminium with a bright matt finish. From this point on, avoid touching the front of the panel.

4) Attach a length of thin plastic string or tubing to the panel by tying it through one of the panel holes.

5) Prepare a caustic etching solution. Have about 300 ml of hot water ready in a glass or plastic dish (The plastic throw-away food containers are ideal). Measure out about 30 grams of caustic soda then pour the caustic soda very, very slowly into the hot water. (1 oz of caustic soda in half a pint of water, if that's any easier for you). The strength of the solution is in no way critical. Now, by means of the plastic string, lower the panel into the solution, leaving one end of the string hanging out of the dish. It will fizz fiercely and the solution will get hotter — but all is well.

6) About 3 minutes later remove the panel, rinse it under a cold water tap, and wipe it clean. Rinse it again thoroughly, and if it looks okay — dull matt all over, it's finished. Hang it to dry.

A panel finished this way has a satin chrome look to it, and does not retain finger marks the way untreated aluminium does. ●

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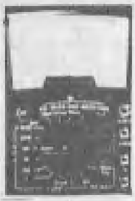

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20,000 ohms per volt. DC volts: 0.025, 1, 10, 50, 250, 500, 1000 (at 20K o.p.v.), 5000 (at 10K o.p.v.). AV volts: 0-10, 50, 250, 1000 (at 8K o.p.v.). DC current: 50uA, 1mA, 50 mA, 500 mA, 10 amps. Resistance: 0-4K, 400K, 4M, 40 megohms. DB scale — 20 to plus 36 dB. Capacitance: 250pF to 0.02uF. Inductance: 0-5000 H. Size: 5¾ x 4-1/6 x 1¾ in.

CT-500/).

Popular, medium-size, mirror scale. Overload-Protected.
AC/V: 10V, 50V, 250V, 500V, 1000V, (10,000Ω/V)
DC/V: 2.5V, 10V, 50V, 250V, 500V, 5000V (20,000Ω/V)
DC/A: 50μA, 5mA, 50mA, 500mA.
OHM: 12kΩ, 120kΩ, 1.2MΩ, 12MΩ,
db: — 20db to +62db.
Approx. size: 5½" x 3-5/8" x 1¾".

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A-10/P

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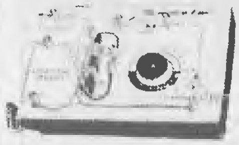
DC/V: 0.5V, 2.5V, 10V, 50V, 250V, 500V, 1000V at (30,000Ω/V) 5000V (10,000Ω/V).
DC/A: 50μA, 1mA, 50mA, 250mA, 1A, 10A.
OHMS: 10kΩ, 100kΩ 1MΩ 100MΩ
db: —20 to +62dB
Signal Injector: Blocking oscillator circuit with a 2SA102 transistor.
Approx. size: 6-2/5" x 7-1/5" x 3-3/5".

MODEL 674

High-gain single sideband or A.M. 23 channel. Transceiver, 5 watts A.M., 15 watts P.E.P. sideband, all channel crystals included. ANL, noise blanker, PTT. mike, 12volt D.C. operation, R.F. output and "S" meter with provision for external receiver VFO control.

ELECTRONIC PROJECT KITS



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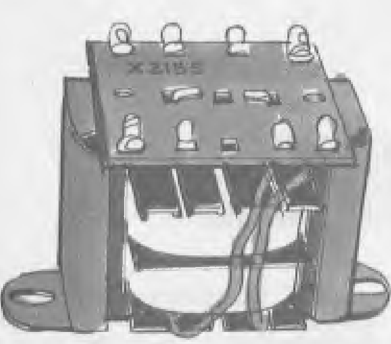
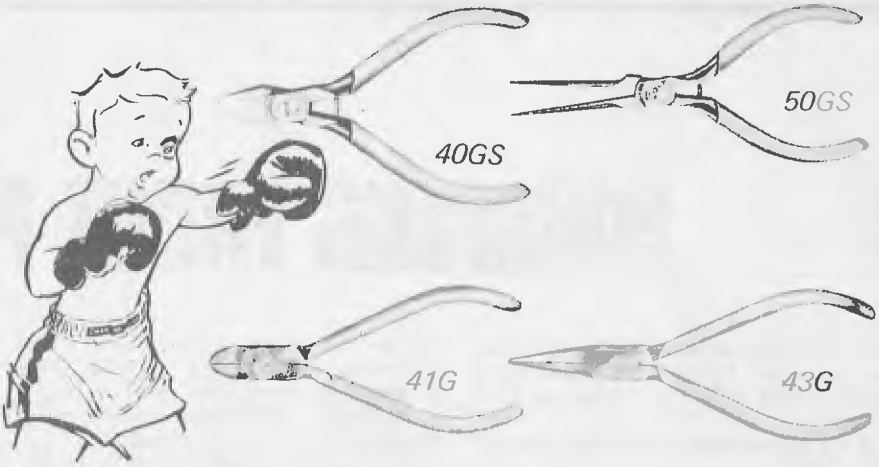


X2155 illustrated



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PROJECT 219,220

TWO SIREN CIRCUITS

Make a minor change to the preceding organ circuit — and there's a hee-haw siren.

HEE-HAW SIREN ETI219

The basic oscillator circuitry of the organ may be used to implement two commonly used siren generators. The first of these is, because of its characteristic sound, called a Hee Haw and is commonly used as a police or ambulance siren.

Operation of both sirens will be readily understood by referring to the description of operation for the integrated circuits and output stage in the monophonic organ which uses very similar circuitry.

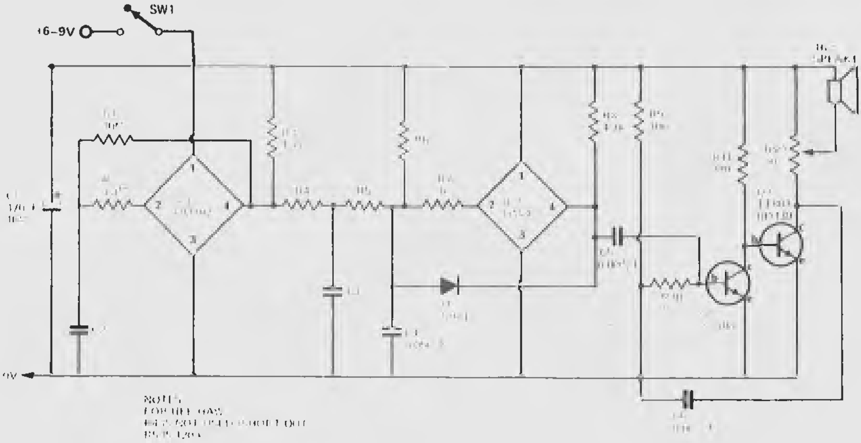
In the case of the Hee-Haw the frequency of IC1 is set to about 1 Hz and the mark/space ratio to 1:1. The output frequency is controlled by R6, through which C4 charges, and R4 and R5 which will either help charge C4 (higher frequency) or remove current from C4 (lower frequency). The ratio of R6/R4+R5 determines the difference in pitch of the two frequencies. No tune control is required and hence pin of IC2 is connected directly to the positive rail.

WAILING SIREN ETI 220

By altering the circuit slightly the more conventional fire-brigade type siren is obtained. Here IC1 operates at a lower frequency (about 0.25 Hz) and the output of IC1 is filtered to provide the slow smooth change required.

The component values specified provide approximately one octave between the two extremes of frequency in both cases.

These three circuits, organ, hee haw and siren dramatically illustrate how the same basic circuitry can be used to perform a variety of tasks. Note also the black-box concept, all three consist of two oscillators and an audio amplifier. A little thinking about the differences between these circuits will give the constructor much insight into electronics. ●



NOTES
FOR HEE HAW
R4 IS NOT USED (SHORT OUT)
R5 IS 120k
R6 IS 47k
C2 IS 0.1µF
C3 NOT USED LEAVE OPEN
FOR SIREN
R4 IS 39k
R5 IS 18k
R6 IS 33k
C2 IS 0.39µF
C3 IS 100µF 16V

Circuit diagram for both sirens.

PARTS LIST HEE HAW SIREN ETI 219

R11	Resistor	220Ω	½W 5%
R7,10	"	1 k	" "
R3,8	"	4.7 k	" "
R9	"	10 k	" "
R6	"	47 k	" "
R5	"	120 k	" "
R2	"	3.3 M	" "
R1	"	10 M	" "
C5	Capacitor	0.001µF polyester	
C4	"	0.056µF	"
C6	"	0.068µF	"
C2	"	0.1µF	"
C1	"	470µF electrolytic	
IC1,2	Integrated circuit OM802		
Q1	Transistor	BC108	
Q2	"	TT801, BD139	
RV1	Potentiometer	50Ω 1W	
SW1	Single pole ON-OFF switch		
16Ω	Speaker		
D1	Diode	IN914	

piece of matrix board.

PARTS LIST WAILING SIREN ETI 220

All parts as for hee haw except

R4	Resistor	39 k	½W 5%
R5	"	18 k	" "
R6	"	33 k	" "
C2	Capacitor	0.39µF polyester	
C3	"	100µF 16V electrolytic	

SPRING REVERBERATION UNIT

Built-in mixing facilities and stereo operation are provided in this versatile unit.

THE SOUND of many musical instruments may be "enhanced" by the addition of reverberation. Particular examples of instruments, to which reverberation is commonly applied, are the electronic organ and the guitar.

Reverberation is defined as the persistance of sound within an enclosure after the original sound has ceased. It may also be defined as a series of multiple echoes, decreasing in intensity, so closely spaced in time as to merge into a single continuous sound eventually dying away to nothing.

Reverberation, added with discretion, gives life and brilliance to the music from individual instruments which otherwise appear dull and flat. It is less commonly known that, when reproducing recorded material, the addition of reverberation can considerably enhance the liveliness of the material and its apparent spatial depth.

Artificial reverberation can be achieved in several ways. One system employs echo chambers to achieve the delay. A second system employs magnetic tape-loop techniques, whilst a third, the one used in this project, uses an amplifier that drives springs to provide the delay. It is also possible to achieve delay by fully electronic means but, for normal instrumental or home use, the circuitry is prohibitively complex and expensive.

SPECIFICATION

INPUT VOLTAGE	
Maximum	1 volt
Range	100 mV – 1 volt
FREQUENCY RESPONSE	
Direct	–3 dB at 20 Hz, 50 kHz
Delayed	50 Hz – 4 kHz
IMPEDANCE	
Input	approx. 47 k
Output	< 5 k
CROSS TALK	
With 10 k source impedance	– 40 dB
GAIN	
Maximum	unity
SIGNAL TO NOISE RATIO	
Direct	> –60 dB ref IV
Reverberation	> –50 dB ref IV

The unit described is based on a readily available reverberation spring assembly and is suitable for incorporation into existing amplifier instrumental setups, or for adding reverberation to the reproduction from stereo Hi-Fi systems.

In March of 1972 a simpler unit was described in Electronics Today. This was very popular but, required a separate mixer in order that the generated echo and original signal could be combined in controllable proportions.

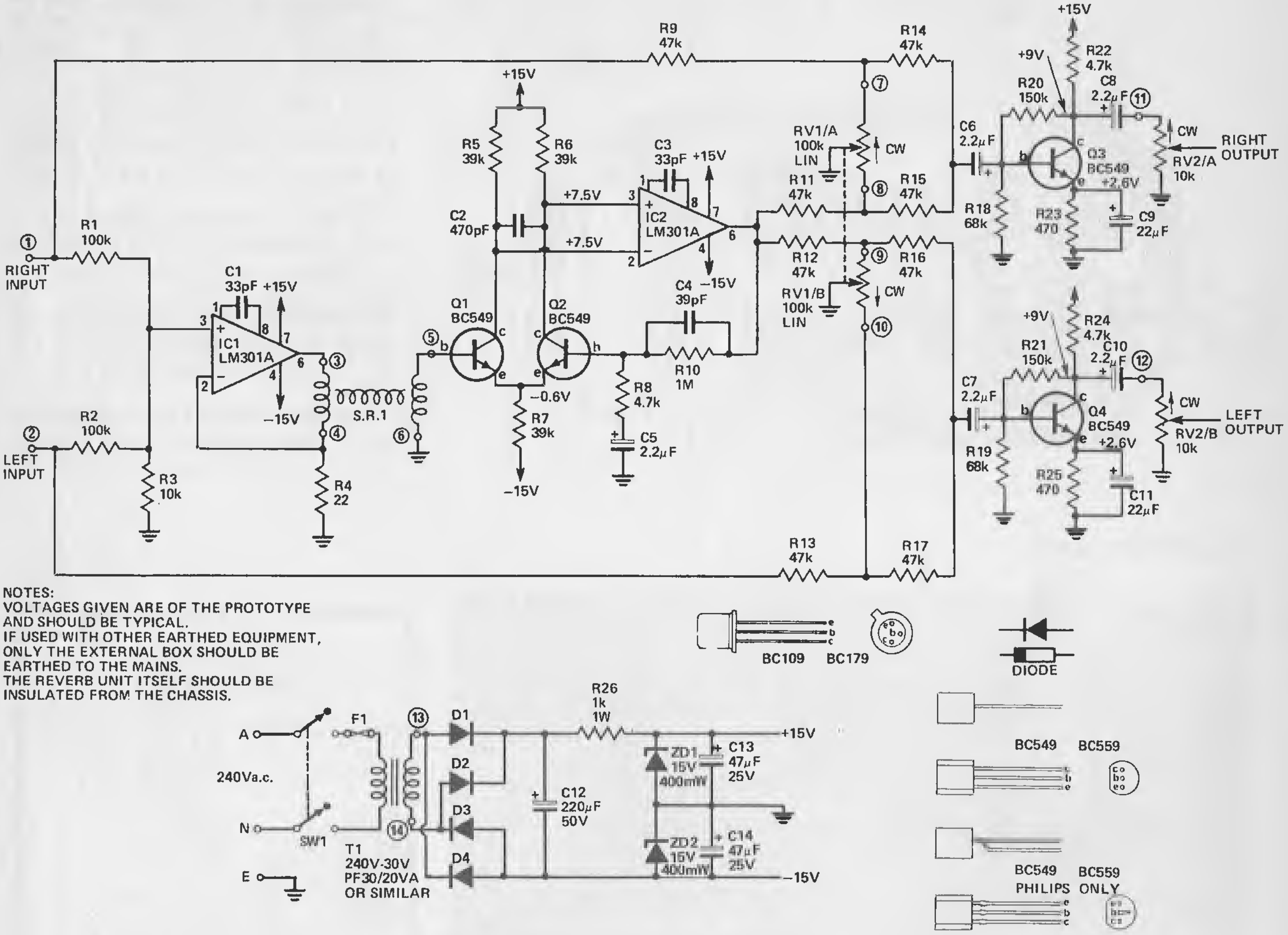
This unit has the required mixing facilities built-in, the proportion of echo to original signal being adjustable by a control called DEPTH. In addition, we decided to make the unit capable of adding reverberation to stereo systems. This involves very few extra components since both channels are mixed into the reverb spring and the combined echo then separately mixed with the original left and right channels. This extra expense is only that of an extra transistor stage and is well justified, even if the unit is mainly intended for monophonic work.

As the unit is completely functional within itself, and fitted into a strong but attractive metal cabinet it will be equally suitable for use by professionals or high-fidelity audio enthusiasts.

CONSTRUCTION

We housed our unit in a simple pan-shaped chassis with metal cover.

PROJECT 424



NOTES:
VOLTAGES GIVEN ARE OF THE PROTOTYPE AND SHOULD BE TYPICAL.
IF USED WITH OTHER EARTHED EQUIPMENT, ONLY THE EXTERNAL BOX SHOULD BE EARTHED TO THE MAINS.
THE REVERB UNIT ITSELF SHOULD BE INSULATED FROM THE CHASSIS.

Fig. 1. Circuit diagram of the spring reverberation unit.

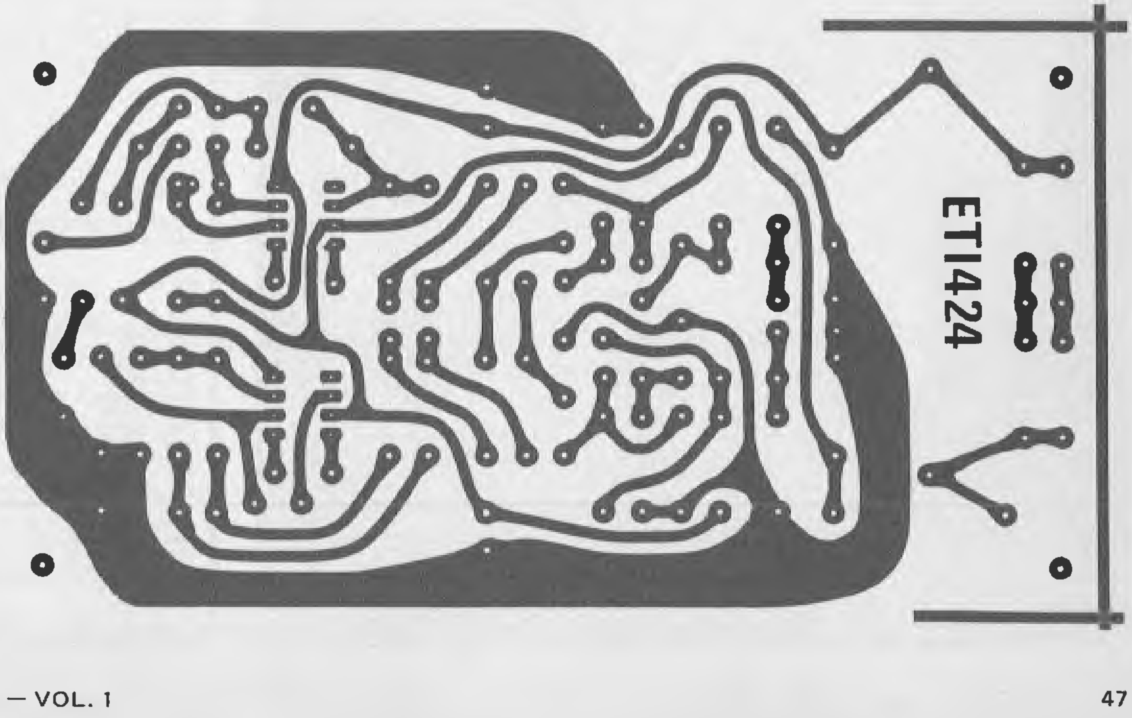


Fig. 2. Full size printed circuit board layout.

SPRING REVERBERATION UNIT

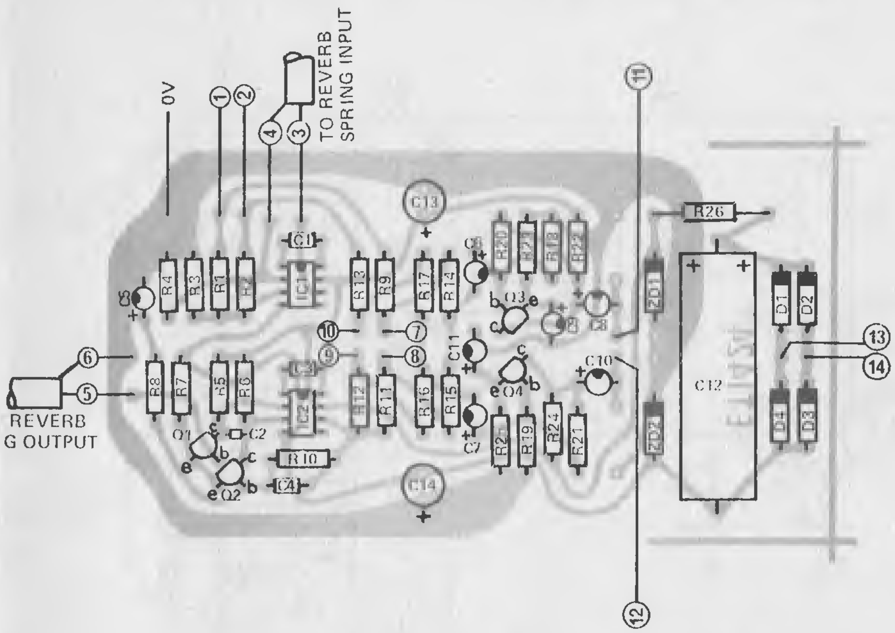


Fig. 3. Component overlay.

This enables the unit to be used as a flexible system component, but, if desired, the electronics may easily be incorporated within an existing system-box if room permits.

The majority of the components are mounted upon one single printed-circuit board, although matrix or veroboard can quite easily be used if preferred.

Whichever constructional method is used, it is essential to check polarized components, for correct orientation, before soldering. Note especially that two different pin configurations for the BC549 are available and that it is the Philips type which is shown on the overlay.

The input socket of the reverberation spring must be removed and replaced with an insulated type. To do this it is

HOW IT WORKS

The reverberation spring is an electro-mechanical device for delaying and producing echo on audio signals - it operates in the following manner. A relay-like transducer vibrates one end of a spring in response to an input audio signal. The spring continues to vibrate after the excitation has been removed and thereby produces a decaying 'echo' as well as delaying the propagation of the signal to the transducer at the other end.

The mechanical system naturally has many resonances and the frequency response therefore cannot be flat over a small frequency range, but is substantially flat over the broad frequency range of 50 Hz to 4 kHz.

Integrated circuit IC1 is connected so as to provide current drive to the input transducer of the spring. The transducer is inductive and hence, the voltage across it will increase with frequency. However, since the current remains constant, the power in the transducer also remains constant. The stereo input is summed into R3 by resistors R1 and R2 (with a loss of 20 dB) to provide a composite signal at pin 3 of IC1. As the amplifier always tries to keep pin 2 at the same potential as pin 3, the voltage across R4, and the current through it, is therefore proportional to the input voltage. As very little current flows into pin 2 of the IC, all this current flows through the transducer.

The output signal from the transducer at the other end of the spring is very small (about −50dB referred to the input and is therefore amplified back to a reasonable level by Q1, Q2 and IC2. Transistors Q1 and Q2 are low noise types and are arranged as a differential pair to add gain before the inherently noisy IC. The gain is set by (R10+R8)/R8 to about 46 dB. The low frequency cutoff is set by C5 and R8, and the high frequency cutoff by R10 and C4. Note that these last figures refer only to the receiving transducer amplifier and not to the whole system.

The direct inputs, left and right, are now both mixed with the common reverberation signal in mixers Q3 (right) and Q4 (left). The proportion of direct and reverberation signals is adjustable by means of depth control RV1. The gain of the output stage is set by R20, R21 and the bias by R18, 19, the overall gain of the complete system being approximately unity.

If single channel operation only is required, simply delete the second mixer transistor and its associated components. If reverberation only, without the mixing facility, is required the output may be taken direct from pin 6 of IC2.

In the event that a volume control is not required resistors may be fitted to the board (holes provided on board) to set the volume to any desired level. These resistors may have any value between 10 k and 1M.

ETI 424
PARTS LIST

R4	Resistor	22	½W	5%
R23,25	"	470	"	"
R26	"	1 k	1W	"
R8,22,24	"	4.7 k	½W	"
R3,	"	10 k	"	"
R5,6,7	"	39 k	"	"
R9,11,12,13	"	47 k	"	"
R14,15,16,17	"	47 k	"	"
R18,19	"	68 k	"	"
R1,2,	"	100 k	"	"
R20,21	"	150 k	"	"
R10	"	1 M	"	"
RV1	Potentiometer	100k dual lin rotary		
RV2	"	10 k dual log rotary		
C1,3	capacitor	33pF ceramic		
C4	"	39pF ceramic		
C2	"	470pF ceramic		
C5,6,7,8,10	"	2.2μF 10V electrolytic		
C9,11	"	22μF 10V electrolytic		
C12	"	220μF 50V electrolytic		
C13,14	"	47μF 25V electrolytic		

Note: all electolytics except C12 are pc mounting.

D1-D4	diodes	EM401 or equivalent
ZD1-ZD202	Zener diodes	BZX 79 C15 or equivalent
Q1-Q4	transistor	BC549, BC109 or equivalent
IC1,2	operational amplifier	LM301A

PC board ETI 424
SW1 switch 2 pole on-off 240V rated
F1 fuse and fuse holder 500 ma chassis mounting
Spring reverb unit Plessey type 51 or equivalent
T1 transformer PF30/20VA, PF 3600 or equivalent
3 core flex and plug
2-way RCA sockets — 2 off
12mm long spacers 4 off
chassis to Fig. 7
metal cover to Fig. 8
front panel to Fig. 6
rubber grommet for power cord and insulating reverb unit.
insulated RCA socket for reverb.

necessary to enlarge the mounting hole to provide adequate clearance. Take care not to damage the spring mechanism whilst doing this.

The reverberation spring must also be insulated from the chassis by means of rubber grommets or similar. This is necessary to prevent earth loops, when used in conjunction with other equipment, which would cause high hum levels.

The unit should be wired, as shown in Fig. 1, taking care to keep all 240 volt ac wiring well clear of the electronics and especially clear of the receive end of the reverberation spring. The metal case itself should be earthed even though the electronics itself is not earthed.

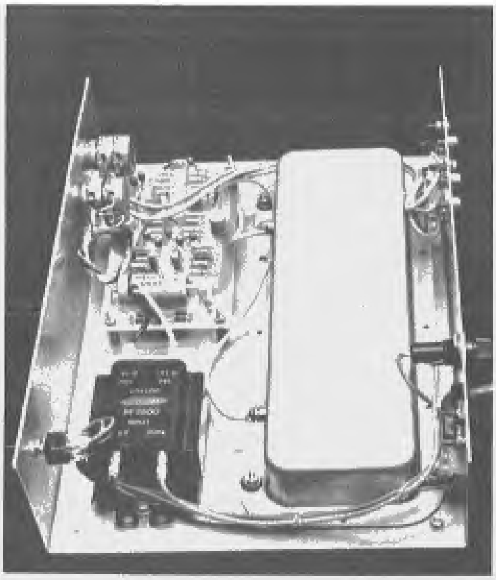


Fig. 4. Method of mounting the hardware and printed circuit board into the chassis is illustrated in this internal view.

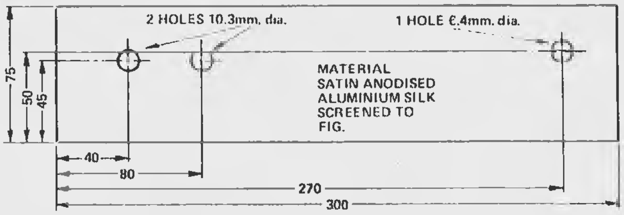


Fig.5 Front panel drilling details.

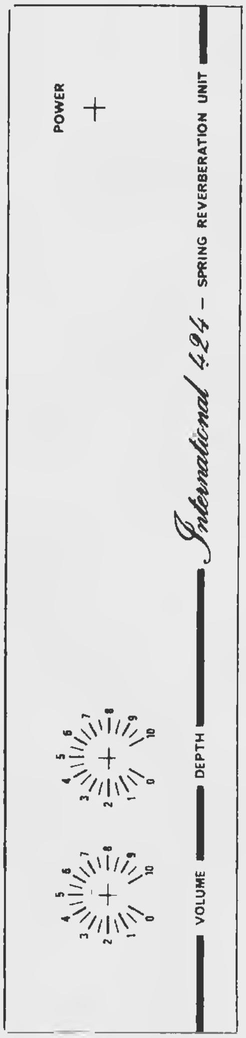


Fig. 6. Front panel artwork for the spring reverberation unit (half size)

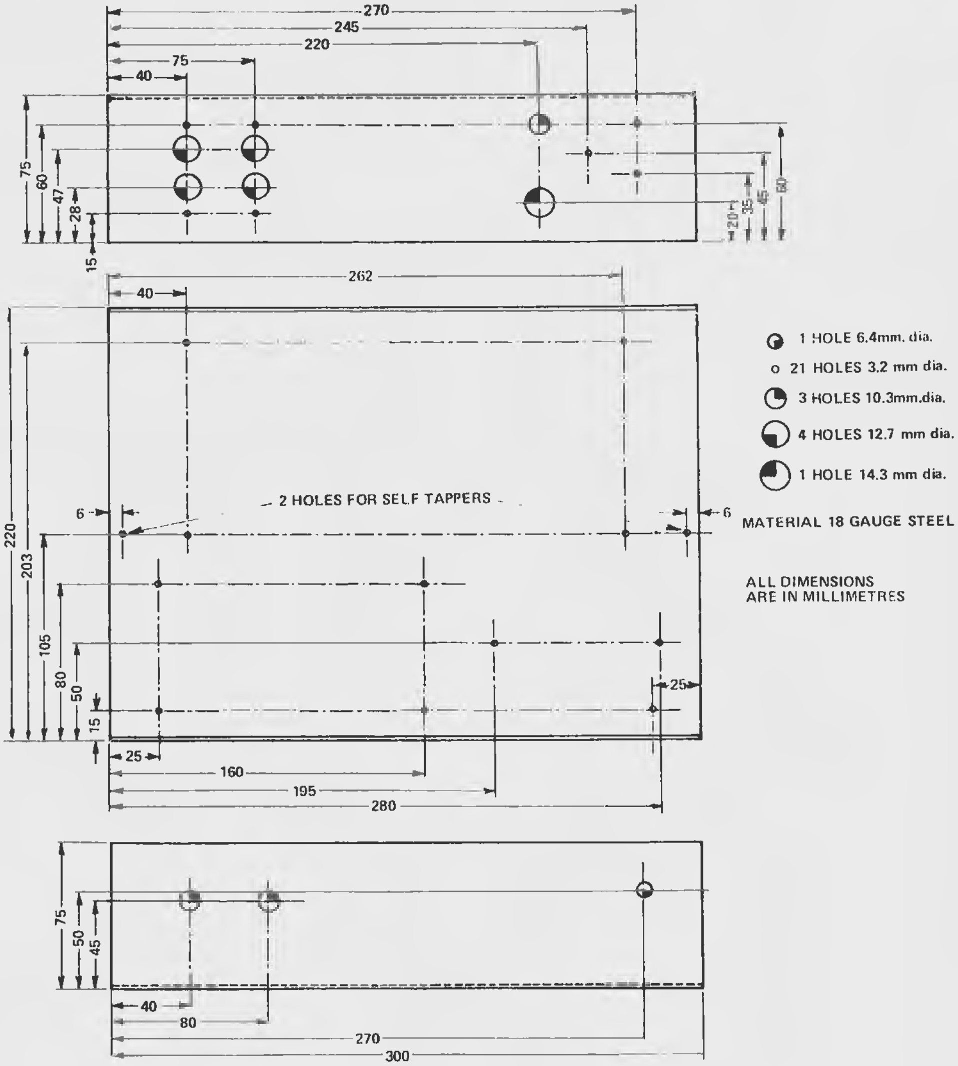


Fig. 7. Dimensions and drilling details of the chassis.

SPRING REVERBERATION UNIT

SETTING UP

As the reverberation spring is a mechanical device, vibration will produce unwanted outputs. Hence it is an inherently noisy device and should be used at a point in the system where the signal level is high.

Two typical points at which the unit may be inserted in the system are:—

1. Between the preamplifier and the main amplifier.
2. After the disc preamplifier, or high level input and the preamplifier.

If inserted between pre and main-amplifiers, i.e. after the volume control, turn the reverb volume control to maximum and adjust the preamplifier volume control such that the main amplifier is just below clipping level. The reverb volume control can then be used to set the level required.

If the reverberation unit is inserted before the system volume control, the volume control on the reverberation unit should be set to maximum (or deleted altogether if desired) and the preamplifier volume control used to set the required level. ●

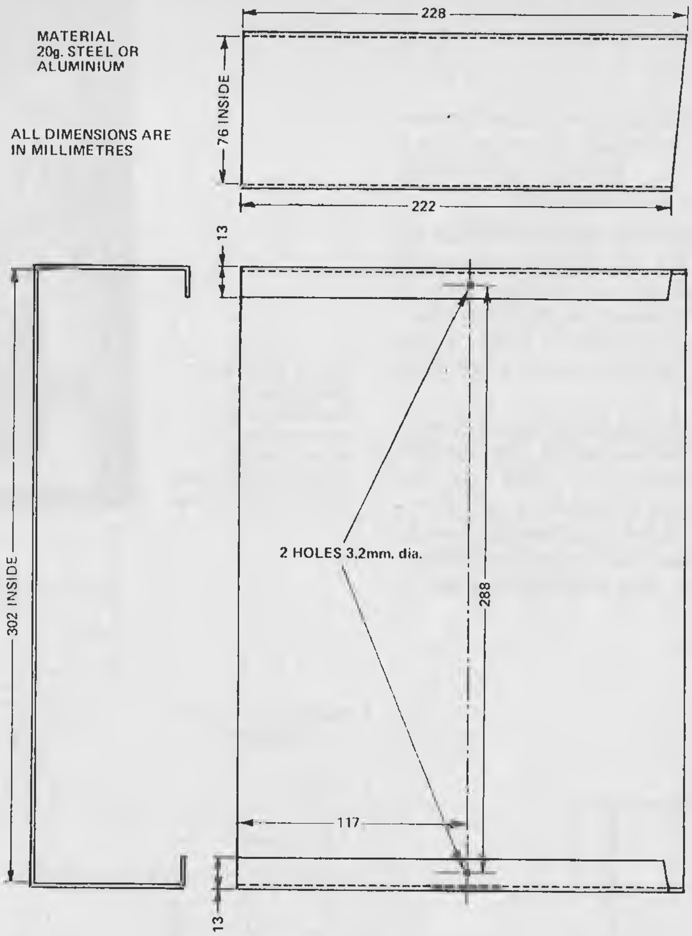


Fig. 8. Detail of the cover.

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SIMPLE LOUDHAILER

PROJECT 208

This cheap and simple loudhailer can be built in a few hours

HERE's a simple device to save your voice at sports meetings, large picnics or any other occasion that requires you to raise your voice above the surrounding noise.

It needs a minimum of components, all of which are easily obtainable; it is cheap and can be built in a very short space of time.

THE CIRCUIT

The circuit is shown in Fig. 1. A single transistor (Q1) is arranged as an amplifier with resistor R2 providing the necessary bias. The resistance of the carbon microphone will vary as sound is impressed upon the diaphragm, thus varying the voltage across R1.

Resistor R1 is ac coupled to the base of the transistor Q1. This transistor amplifies the signal and drives the speaker.

CONSTRUCTION

All the minor components are easily mounted on a single tagstrip (as shown in Fig. 2). This tagstrip may be bolted to one wall of the loudhailer enclosure and wiring taken to the microphone, speaker, pushbutton and battery.

Any suitably enclosed box of the right dimensions, may be used to house all the components including the battery and the speaker.

Generally, the larger the speaker the better, but remember this is a loudhailer not a public address system!

The back of the carbon must be enclosed to prevent feedback from the loudspeaker — if this is not done the system will oscillate.

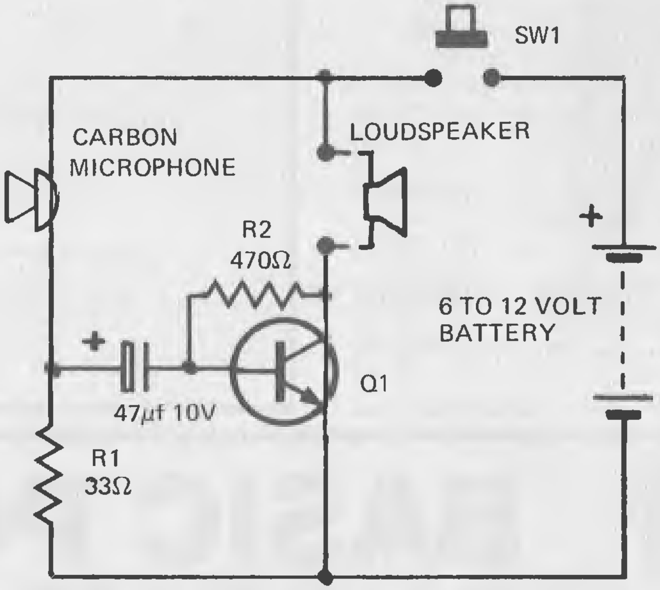


FIG. 1 CIRCUIT DIAGRAM

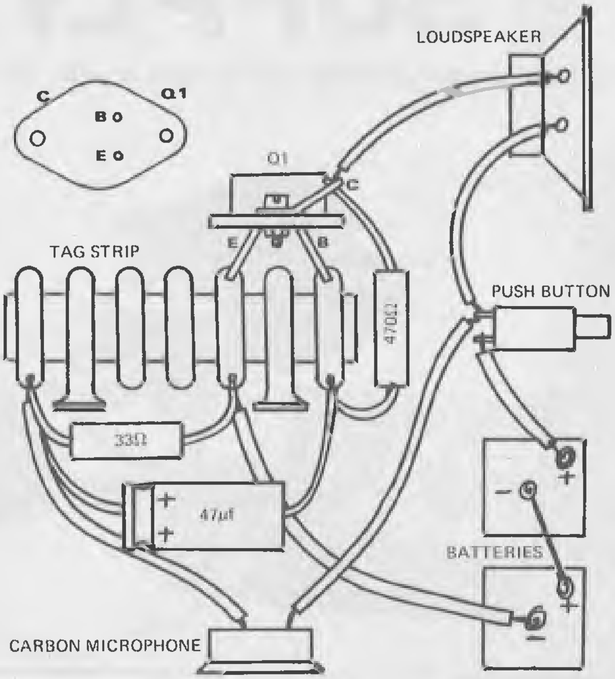


FIG. 2
COMPONENT CONNECTIONS

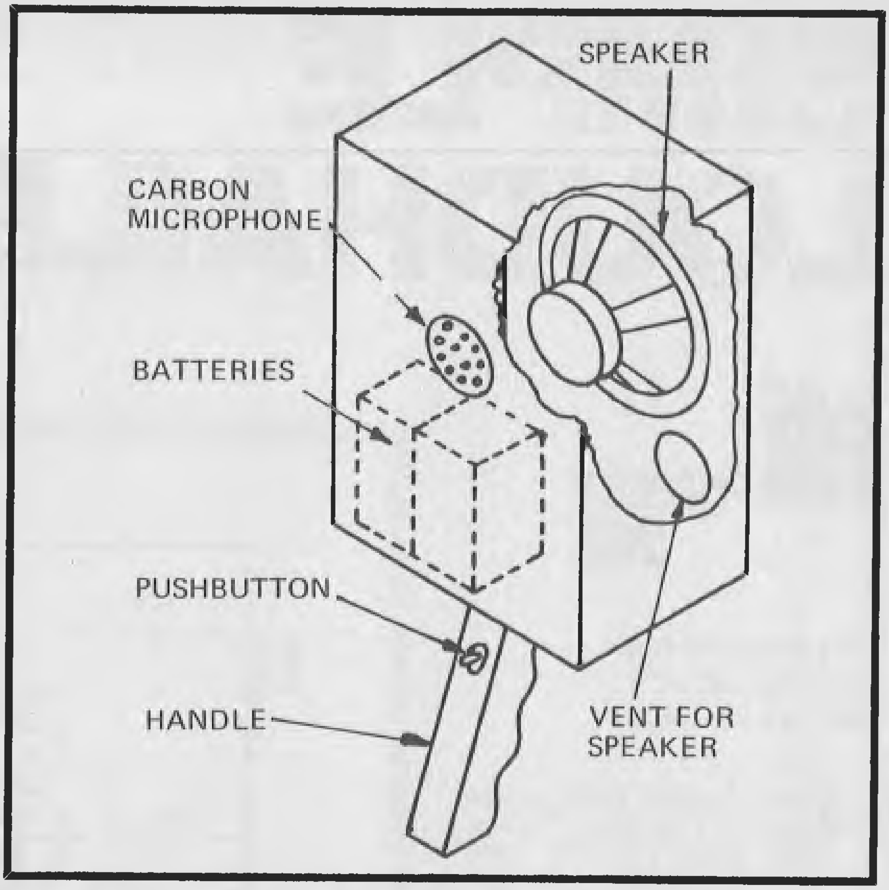
SIMPLE LOUDHAILER

A sketch, showing one suggested arrangement for mounting the components, is shown in Fig. 3. The layout is not critical however. Practically any arrangement that is convenient to you will work satisfactorily.

The unit is surprisingly effective — and quality is excellent — despite the bias caused by some dc energization of the loudspeaker voice coil. ●

PARTS LIST ET 208

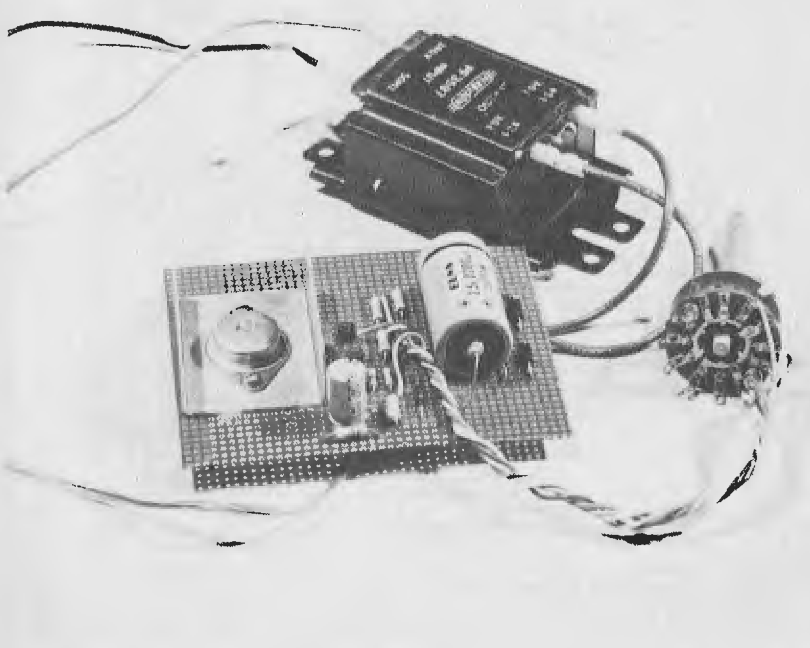
R1 resistor, 33 ohm, ½ watt, 5%
R2 resistor, 470 ohm, ½ watt, 5%
SW1 small push to-make switch
C1 capacitor 47 μF, 10 Volt electrolytic
Q1 transistor type 2N 3055, 40250, 2N 3054, SE 7010 or suitable equivalents.
Loudspeaker -- 3" to 8" diameter, 4 ohm to 15 ohm impedance.
Batteries — two type 509 lantern batteries.
Carbon microphone — Zephyr type 196 (or similar).
One seven lug tagstrip, connecting wire, box, etc.



PROJECT 221

BASIC POWER SUPPLY

Simple regulated supply provides 4.5-12 volts at 400 mA maximum.



The power supply shown unmounted. Note the aluminium heat sink for the power transistor.

THIS little power supply provides a range of switch selectable output regulated voltages from 4.5 to 12 volts, selectable by a switch. The supply will provide up to 400 mA (800 mA when modified for use with the organ described elsewhere) and the output can withstand a short circuit without damage. It is therefore ideal for the experimenter or for use with high drain appliances.

PARTS LIST
POWER SUPPLY ETI 221

R6	Resistor	1.5 ohms ½ W 5% (2 x 1.5 ohms in parallel for organ)
R7	"	220 ohms ½ W 5%
R3	"	820 " " "
R1, 8	"	1k " "
R4, 5	"	1.5k
R2	"	2.7k
Q1	Transistor	PN3643 or similar
Q2	"	2N3055 "
Q3	"	PN3638 "
D1-D4	Diode	EM401 or similar
ZD1	Zenerdiode	BZY88C13 "
T1	Transformer	240V/15V @ 1A
SW1	DPST	240V switch
SW2	4 position single pole switch	
	heatsink for Q2	
C1	Capacitor	2200μF 25V electrolytic
C2	"	100μF 16V "

Piece of matrix board.

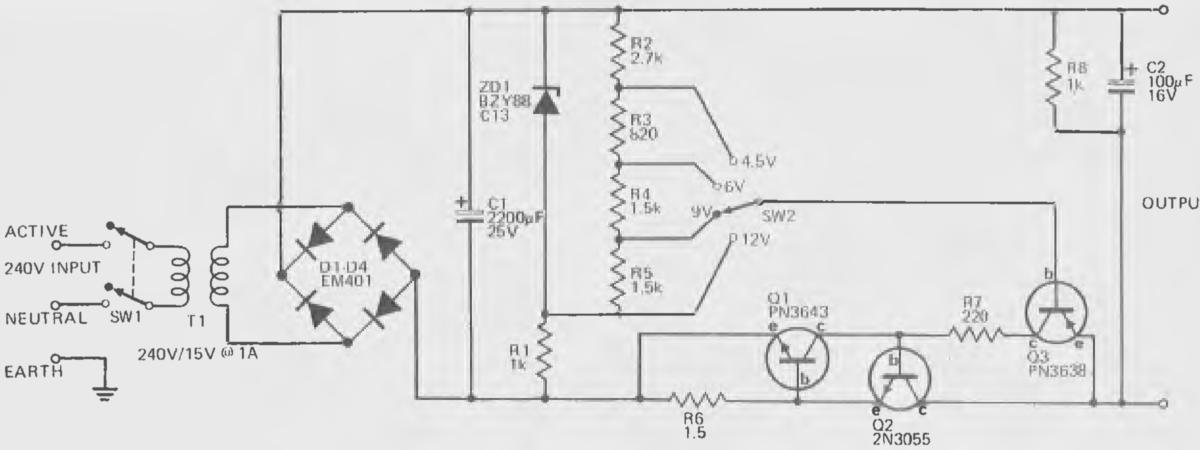


Fig. 1. Circuit diagram of the regulated power supply. Note that when used to power the monophonic organ, R6 should be 0.75 ohms (2 x 1.5 Ω in parallel). This increases the output current capability to about 600 mA.

SPECIFICATION

Nominal output voltage 12 V, 9 V, 6 V, and 4.5 V

Output current 0 – 300 mA

Current limit approx. 500 mA

* except when modified for use with organ.

HOW IT WORKS

The 240 V mains voltage is reduced to 15 volts by transformer T1, and this secondary voltage is then full-wave rectified by rectifier bridge D1-D4.

The output of the bridge rectifier is filtered by C1 to provide approximately 20 volts dc.

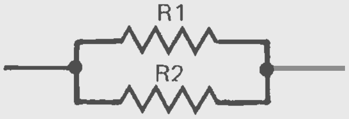
The series combination, of Zener diode ZD1 fed by resistor R1, provides a stabilized voltage of around 13 volts which is applied across the voltage divider R2, R3, R4 and R5. Thus a series of reference voltages are generated for the regulator, where the positive rail is fixed and the negative rail is the one that is varied.

Transistor Q3 is an emitter follower where the output (emitter) is about 0.6 V higher (more positive) than the base. The base voltage is selected by SW2 from one of the tappings on the reference-voltage divider. Since Q3 cannot handle the required output current, it drives Q2, a power transistor, which *can* handle the required load.

When the load exceeds 400 mA (approximately), the voltage drop across R6 forward biases Q1 which turns on and shunts current away from the base of Q2. Thus the regulator loses control and the output voltage falls, limiting the current to 400 mA. As the power dissipated in Q2 under short-circuit conditions is around 10 watts, Q2 must be fitted to a heatsink. Additionally, resistor R7 limits the current supplied by Q3 to a safe value (for Q3) under short circuit conditions.

If a fully variable supply is required, a 10 k potentiometer should be used in place of the voltage divider. The wiper of the potentiometer is then fed directly to the base of Q3.

RESISTORS IN PARALLEL



R2 \ R1	10	12	15	18	22	27	33	39	47	56	68	82	100
10	5.00	5.45	6.00	6.43	6.88	7.30	7.67	7.96	8.25	8.48	8.72	8.91	9.09
12	5.45	6.00	6.67	7.20	7.76	8.31	8.80	9.18	9.56	9.88	10.20	10.47	10.71
15	6.00	6.67	7.50	8.18	8.92	9.64	10.31	10.83	11.37	11.83	12.29	12.68	13.04
18	6.43	7.20	8.18	9.00	9.90	10.80	11.65	12.32	13.02	13.62	14.23	14.76	15.25
22	6.88	7.76	8.92	9.90	11.00	12.12	13.20	14.07	14.99	15.79	16.62	17.35	18.03
27	7.30	8.31	9.64	10.80	12.12	13.50	14.85	15.95	17.15	18.22	19.33	20.31	21.26
33	7.67	8.80	10.31	11.65	13.20	14.85	16.50	17.88	19.39	20.76	22.22	23.53	24.81
39	7.96	9.18	10.83	12.32	14.07	15.95	17.88	19.50	21.31	22.99	24.79	26.43	28.06
47	8.25	9.56	11.37	13.02	14.99	17.15	19.39	21.31	23.50	25.55	27.79	29.88	31.97
56	8.48	9.88	11.83	13.62	15.79	18.22	20.76	22.99	25.55	28.00	30.71	33.28	35.90
68	8.72	10.20	12.29	14.23	16.62	19.33	22.22	24.79	27.79	30.71	34.00	37.17	40.48
82	8.91	10.47	12.68	14.76	17.35	20.31	23.53	26.43	29.88	33.28	37.17	41.00	45.05
100	9.09	10.71	13.04	15.25	18.03	21.26	24.81	28.06	31.97	35.90	40.48	45.05	50.00
120	9.23	10.91	13.33	15.65	18.59	22.04	25.88	29.43	33.77	38.18	43.40	48.71	54.55
150	9.38	11.11	13.64	16.07	19.19	22.88	27.05	30.95	35.79	40.78	46.79	53.02	60.00
180	9.47	11.25	13.85	16.36	19.60	23.48	27.89	32.05	37.27	42.71	49.35	56.34	64.29
220	9.57	11.38	14.04	16.64	20.00	24.05	28.70	33.13	38.73	44.64	51.94	59.74	68.75
270	9.64	11.49	14.21	16.88	20.34	24.55	29.41	34.08	40.03	46.38	54.32	62.90	72.97
330	9.71	11.58	14.35	17.07	20.63	24.96	30.00	34.88	41.14	47.88	56.38	65.68	76.74
390	9.75	11.64	14.44	17.21	20.83	25.25	30.43	35.45	41.95	48.97	57.90	67.75	79.59
470	9.79	11.70	14.54	17.34	21.02	25.53	30.83	36.01	42.73	50.04	59.41	69.82	82.46
560	9.82	11.75	14.61	17.44	21.17	25.76	31.16	36.46	43.36	50.91	60.64	71.53	84.85
680	9.86	11.79	14.68	17.54	21.31	25.97	31.47	36.88	43.96	51.74	61.82	73.18	87.18
820	9.88	11.83	14.73	17.61	21.43	26.14	31.72	37.23	44.45	52.42	62.79	74.55	89.13
1000	9.90	11.86	14.78	17.68	21.53	26.29	31.95	37.54	44.89	53.03	63.67	75.79	90.91

FET DC VOLTMETER

eti PROJECT 110

This cheap and easily constructed dc voltmeter has 10 Megohm input resistance.

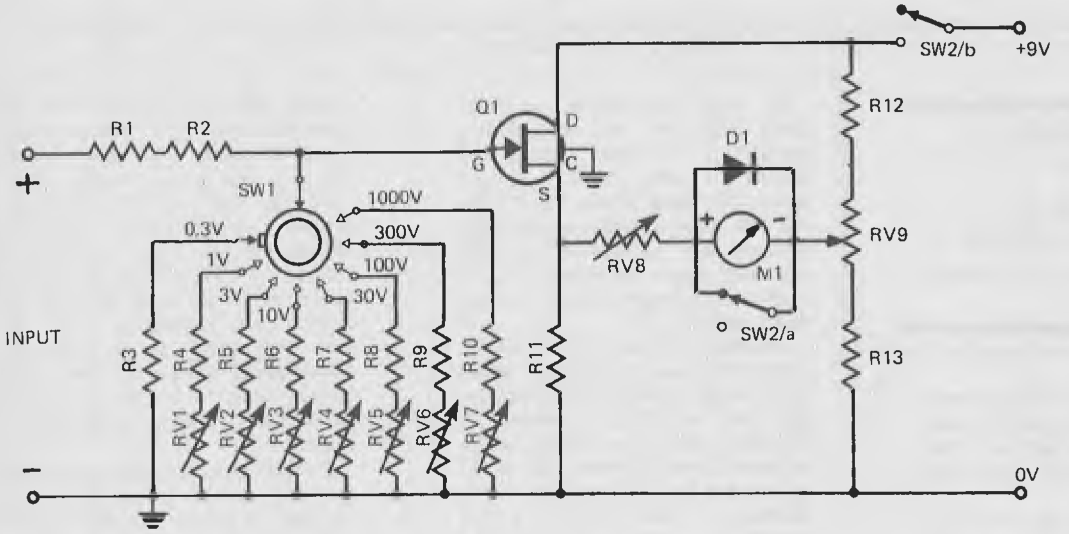


Fig. 1. Circuit of complete instrument.

PARTS LIST — ETI 110

R1, R2	–	5 Meg 5% ½W	
R3	–	18M	
R4	–	2.2M	
R5	–	560k	
R6	–	180k	
R7	–	56k	
R8	–	18k	
R9	–	5.6k	
R10	–	1.8k	
R11	–	4.7k	
R12	–	680 ohm	
R13	–	120 ohm	
RV1	–	470k	trim pot
RV2	–	220k	"
RV3	–	47k	"
RV4	–	22k	"
RV5	–	4.7k	"
RV6	–	2.2k	"
RV7	–	470 ohm	"
RV8	–	4.7k	"
RV9	–	250 ohm ww pot	
Q1	–	BFW 61 BFW 10, BFW 11	
D1	–	OA91	
SW1	–	Single pole eight position rotary switch	
SW2	–	DPDT Toggle Switch	
M1	–	50 uA meter 0-10 and 0-3.16 scales.	

For accurate voltage measurements in high impedance circuits it is essential that the measuring instrument has an input resistance that is very much higher than the circuit being measured. If the meter drains current away from the point being measured then an inaccurate reading will be obtained.

The valve voltmeter (VTVM), with its inherently high input resistance has for many years been used for such measurements.

But until the advent of the field effect transistor (FET), solid state technology was not commonly used in these instruments, for the bi-polar transistor has the disadvantage of having an inherently low input impedance.

The field effect transistor, on the other hand, has a *high* input impedance and because of this, forms an excellent basis for a high input resistance voltmeter.

Here then are constructional details of a simple yet accurate FET dc voltmeter having an input resistance greater than 10 megohms on all ranges.

The attainable accuracy is very much determined by the quality of the 50 uA meter (M1). We have not specified any particular make or type, for this will be determined by the accuracy required. Generally however the meter chosen should be at least four inches in diameter and should have a guaranteed 1% to 2% accuracy at full scale deflection.

Three types of FET may be used in this circuit — BFW10, BFW11, and BFW61. Of these the BFW61 is the cheapest and this is the one that we have used in this project.

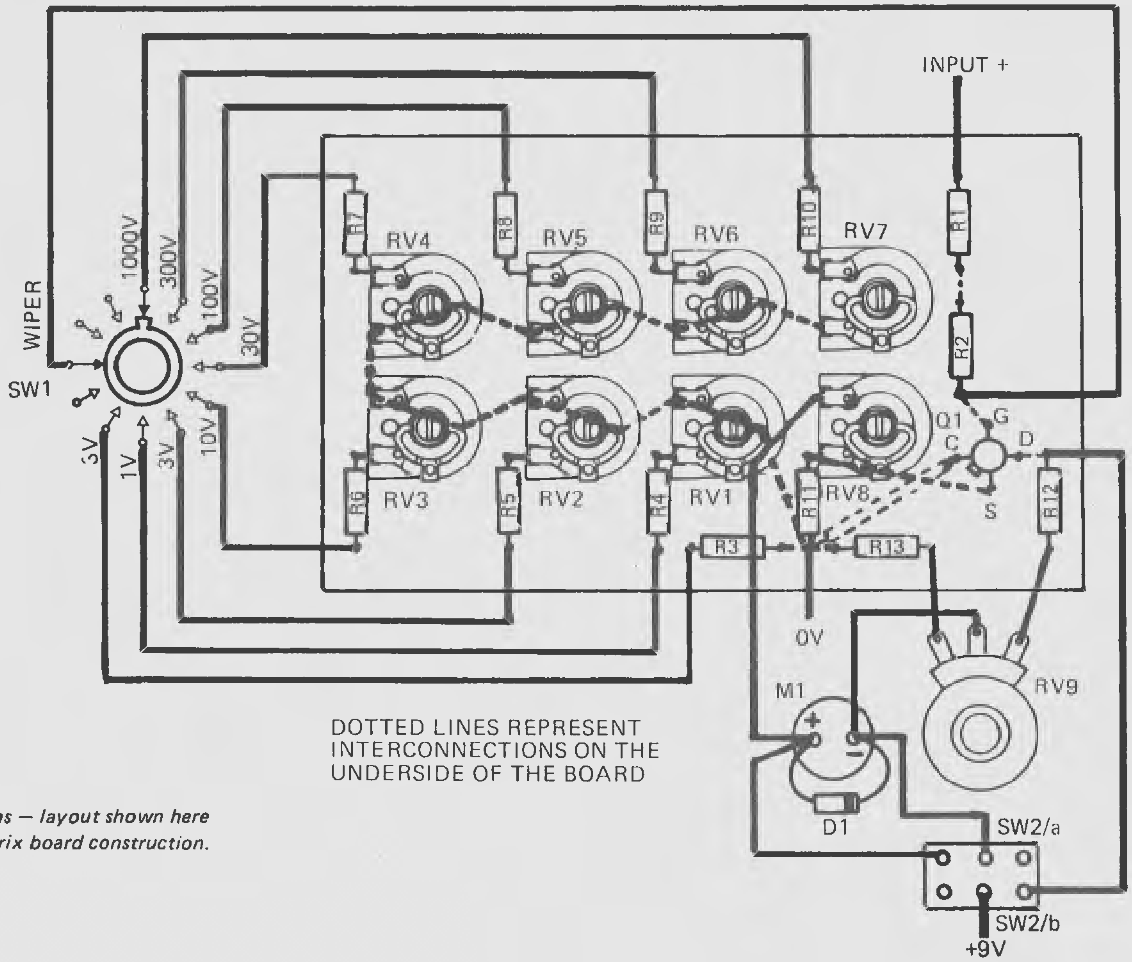
High stability resistors must be used throughout. These should be of 5% tolerance (or better). Metal film resistors — such as those produced by IRH or Philips are ideal. Corning Electrosils are also an excellent choice.

CONSTRUCTION

The physical design of the instrument is determined primarily by the size and shape of the 50 uA meter. Within reason the larger this is the better.

A good quality switch must be used for SW1 — preferably of ceramic construction. A single-pole twelve-way switch was used in the prototype (four of the available positions were not used for switching).

The electronic components may be located on tag strips or on matrix



DOTTED LINES REPRESENT INTERCONNECTIONS ON THE UNDERSIDE OF THE BOARD

Fig. 2. Interconnections — layout shown here is suited to matrix board construction.

board. A matrix board layout is shown in Fig. 2.

As FET's are a bit touchy about input voltage it is wise to keep their terminal leads shorted together by a thin strand of wire whilst soldering them into the circuit.

The battery 'on/off' switch should be double-pole double throw. When it is in the 'off' position the second set of switch contacts place a short circuit across the meter movement thus protecting it against mechanical damage whilst the instrument is not in use.

This switch together with range switch SW1 and 'zero-adjust' potentiometer RV9 must be mounted on the front panel of the instrument case.

CALIBRATION

1. Connect the meter to a nine volt battery. Make sure that the polarity is correct. Switch the instrument to 'on'.
2. Switch SW1 to the .3V range. Short circuit the input terminals and adjust the 'zero-set' potentiometer (RV9) for zero meter deflection. Then remove the short circuit.
3. Apply an accurately known 300mV to the meter input terminals and adjust RV8 to obtain full scale deflection on the meter.
4. Repeat steps 2 and 3 until the meter reads correctly both at zero and full scale deflection. Once this has been achieved do not readjust RV8. during any subsequent operation.
5. Switch the meter to the 1V range, apply an accurately known 1V and adjust RV1 to obtain full scale deflection.
6. Now switch to the other ranges in turn and, in a similar fashion to operation 5, apply the appropriate input voltage and adjust the appropriate potentiometers for each range (RV2, RV3, RV4, RV5, RV6, and RV7) to obtain full scale deflection on each range. This completes calibration. ●

HOW IT WORKS

An eight position switch selects the desired input voltage range. The voltage to be measured is then divided by input resistors R1 and R2 and the resistors selected by the setting of SW1. The division ratio is such that approximately 220 mV is applied to the gate of the FET with 100% input.

The naturally high input resistance of the FET together with negative feedback from R11 ensures that, even on the lowest range there is never less than 18 Megohms in parallel with the lower end of the input voltage divider. This will have a negligible effect on meter accuracy.

Another advantage of using negative feedback is that this limits the working range of the FET thus ensuring good linearity.

All voltage ranges – except the 0.3V range – have a preset potentiometer for initial calibration. Once set, these will not require subsequent adjustment unless a voltage divider resistor or the FET is replaced.

Potentiometer RV8 establishes full scale deflection on the 0.3 V range. It is also used to correct for any spread in the transfer conductance (gain) of the FET.

The 250 ohm wire wound potentiometer RV9 is mounted on the front panel of the instrument and is used as a 'zero adjustment'. In effect it cancels out the voltage appearing at the source terminal of the FET when there is zero voltage at the input.

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THINGS WORTH KEEPING

Aerosol caps: The polythene caps without an inner sleeve are useful moulds if ever you go in for plastic casting or encapsulation.

Ball pens: The outer tube makes excellent spacers; the inner tube makes a useful screw holder; the brass nozzle provides very small brass tubing which would be very hard to get.

Batteries: The 9 volt transistor radio battery cap is easily removed and makes a good battery connector.

Chipboard: Small scraps are useful for breadboarding projects, and for a base while drilling holes.

Food containers: Plastic trays of food containers make useful etching baths.

Ice Cream boxes: Same as food containers — useful for etching pc boards or aluminium panels.

Jars with screw caps: Storage of nuts, bolts, washers etc. Caps can be fixed to the underside of a shelf and jars screw in. Jar caps on plastic 'spring' make good push buttons on aluminium panels.

Metal: Of all types. Endless uses in construction work — clips, brackets, panels etc.

Perspex: Even small bits provide good insulating mounts for flash tubes.

Pill tubes: i.e. the plastic boxes pills come in. Useful for storage of components.

Plastic sheeting and bags: The thick plastic sheeting on old diaries and desk blotters is useful for insulating cases. Bags help keep parts clean and tidy.

Plastic boxes: Boxes of the margarine type make useful storage boxes, or parts boxes for bench use — when a unit is being disassembled.

Plywood: Very useful for breadboarding work. Use small nails as anchor points. Can be used over and over again.

Potentiometers: Long after the track is worn out the spindle and bush are good for axles and bearings, pulleys etc.

Slide boxes: The plastic of boxes in which slides come from the processors provides good insulating material.

Tin boxes: Metal boxes of all shapes and sizes should be kept — for cases of projects, storing drills and so on.

Transformers: From old valve sets. It's not hard to rip off the high-voltage secondary and replace it with a hand-wound low-voltage secondary. Count the turns on the 6.3 volt winding as you remove it, and work out volts per turn. — A.J. Lowe

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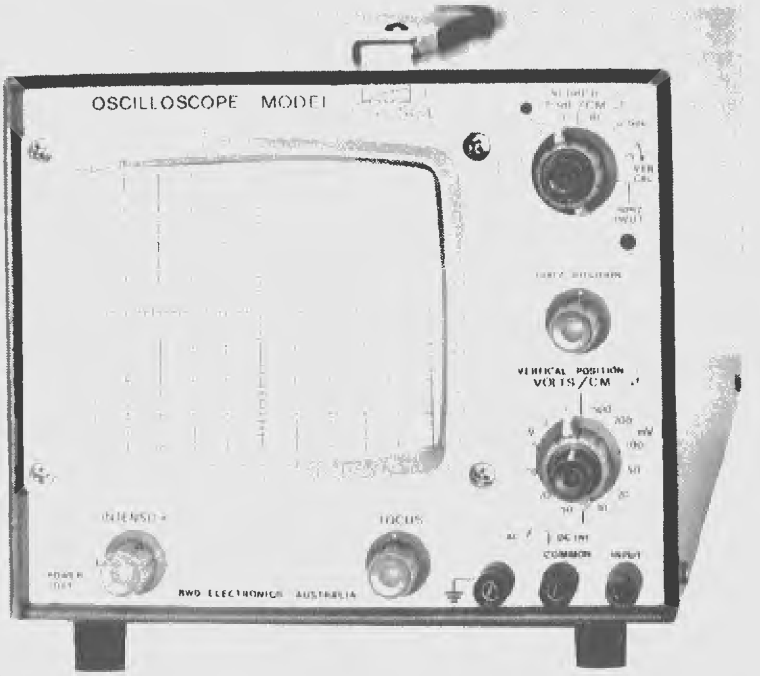


RMIT75

PROJECT 525

DRILL SPEED CONTROLLER

Variable speed control maintains constant (adjustable) speed regardless of load.

MOST HANDYMEN own a power drill.

There are tens of millions of them in use around the world — and they continue to be used for an ever greater variety of tasks.

Despite their popularity, many power drills have one major drawback and this is that their speed is often too high for many applications.

This is so even with dual-speed models where even the slow speed, typically 300-750 RPM, is too fast for such jobs as drilling masonry or using fly-cutters on sheet metal etc.

The speed controller described here allows infinite variation of speeds from zero to about 75% of full speed, and is provided with a switch to allow normal full-speed operation without disconnecting the drill from the controller. The controller has built in compensation to maintain substantially constant speed regardless of changes in load.

CONSTRUCTION

It must be emphasized that the controller is connected directly to the mains without the use of an isolating transformer. Care must therefore be taken with the construction to ensure that there is no likelihood of any dangerous conditions arising.

As there are relatively few components used, no supporting tag strip or PC board is necessary. From the photo of our prototype, and from Fig. 2 it can be seen that only two "mid air" joints need to be made, and these should be carefully insulated to prevent any possibility of short circuits.

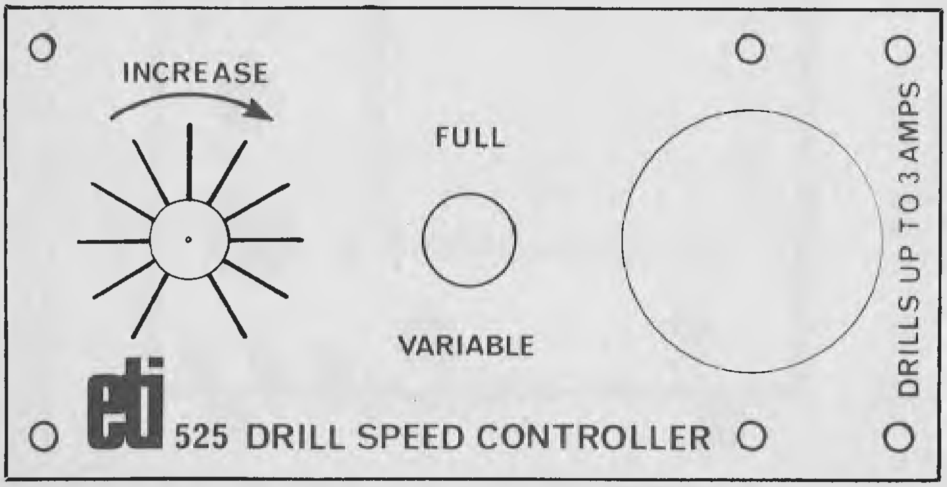
The SCR used is a stud mounting type and is mounted by using the solder lug, supplied with it, soldered onto the centre lug of the switch. For loads up to 3 amps no other heat-sinking is required. If a plastic-pack SCR is used a hole may be drilled through the switch lug and the SCR bolted directly to it. However in this case it is advisable to insert a piece of aluminium (about 25 mm x 15 mm) between the SCR and switch lug to act as a heatsink.

Remember that, since the unit operates at 240 Vac *all external parts must be earthed.* We used a plastic box with a metal lid. But we also used a cable clamp with a metal screw through the side of the plastic box. This screw *must* be earthed, along with the lid and the earth terminal of the output socket. The earth wire should be continuous That is, it should go from one earth point through to the next and not by separate links. Two earth wires may be soldered to one earth lug. But under no account should two wires be secured under a single screw.

The aluminium lid on the (type UB3) box used is not strong enough for this application, especially when the hole for the output socket is cut. A new lid should therefore be made from 18 gauge steel or 16 gauge aluminium.

To further improve safety it is suggested a small amount of glue, lacquer or even nail polish, be used to secure each screw inside the unit.

With some SCRs it may be found that the trigger current supplied by R1 and R2 is insufficient. If this is the case an additional 10 k resistor should be placed in parallel with each resistor.



PARTS LIST ETI 525

R1,2	Resistor	10k 1W 5%
RV1	Potentiometer	2.5 k lin rotary
D1,2	Diodes	EM404 or similar
SCR1	S.C.R.	2SF28 or similar (400V, 10A, max 20ma gate trigger)
SW1	Switch	McMurdo type 475 or similar.

Box type UB3 or similar.
3 core flex and plug.
cable clamp
3 pin power outlet clipsal 415 or similar.

* Some SCRs used may have a higher than average trigger current and the unit may not operate. If so parallel the two 10 k resistor with additional 10 k resistor to increase the available trigger current.

HOW IT WORKS
ETI 525

A universal motor, when running, produces a voltage which opposes the supply. This voltage, called the back EMF, is proportional to the speed of the motor. The SCR drill speed controller makes use of this effect to provide a certain amount of speed-versus-load compensation.

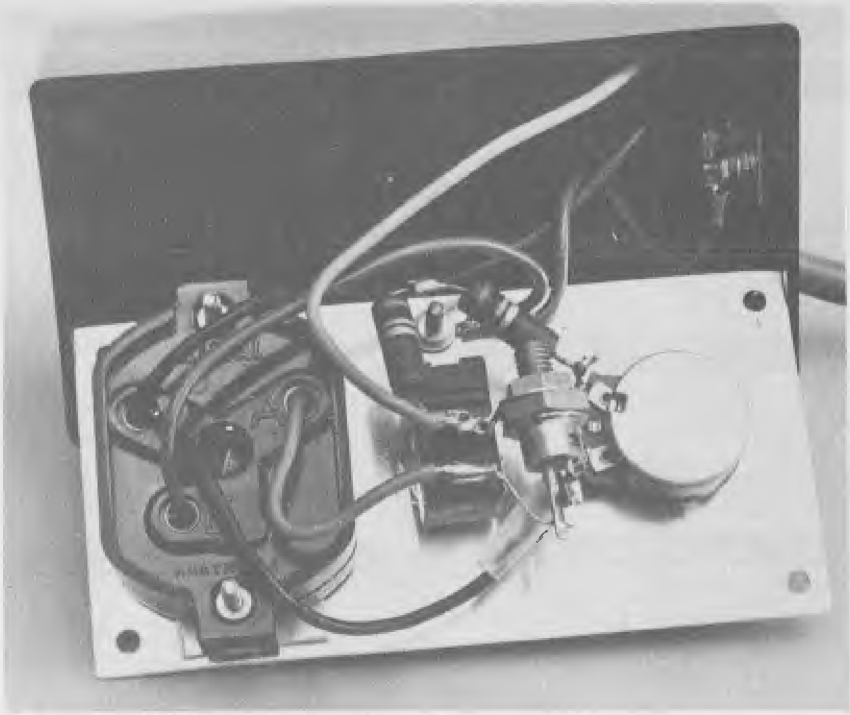
This controller uses an SCR (silicon controlled rectifier) to gate half-wave power to the drill motor. The SCR will conduct only when a anode (terminal A) is positive with respect to the cathode (terminal K), b/ when the gate (terminal G) is at least 0.6 volts positive with respect to the cathode, and, c/ when about 10 mA of current is flowing into the gate terminal. By controlling the level of the voltage waveform to the gate we effectively control the time at which the SCR turns on in each forward half cycle. By this means we effectively control the amount of power delivered to the drill.

Resistor R1, R2 and potentiometer RV1 form a voltage divider which provides a half wave voltage of adjustable amplitude to the gate of the SCR. If the motor is stationary the cathode of the SCR will be at zero volts and the SCR will turn on almost fully. As the drill speed increases, a voltage develops across the drill thus reducing the effective gate-cathode voltage. Thus as the motor speeds up, the power delivered decreases until the motor stabilizes at a speed determined by the setting of RV1.

Should a load be placed on the drill, the drill will tend to slow down, but as the voltage acorss the drill also drops, more power is delivered to the motor since the SCR firing-time is automatically advanced. Hence the speed, once set, is maintained relatively-constant regardless of load.

Diode D2 is used to halve the power dissipated in R1, R2 and RV1 by limiting the current through them to positive half-cycles only. Diode D1 protects the SCR gate against excessive reverse voltage.

In the full speed position the SCR is simply shorted out by SW1. Thus RV1 loses control and full mains supply is applied to the drill.



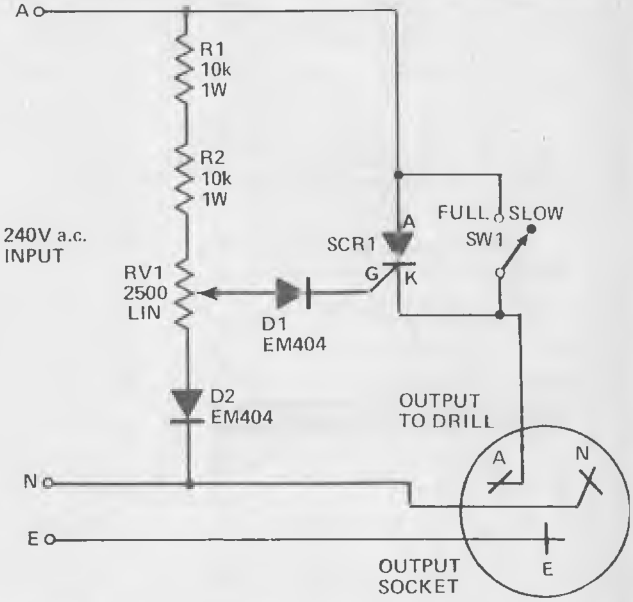


Fig. 1. Circuit diagram of controller.

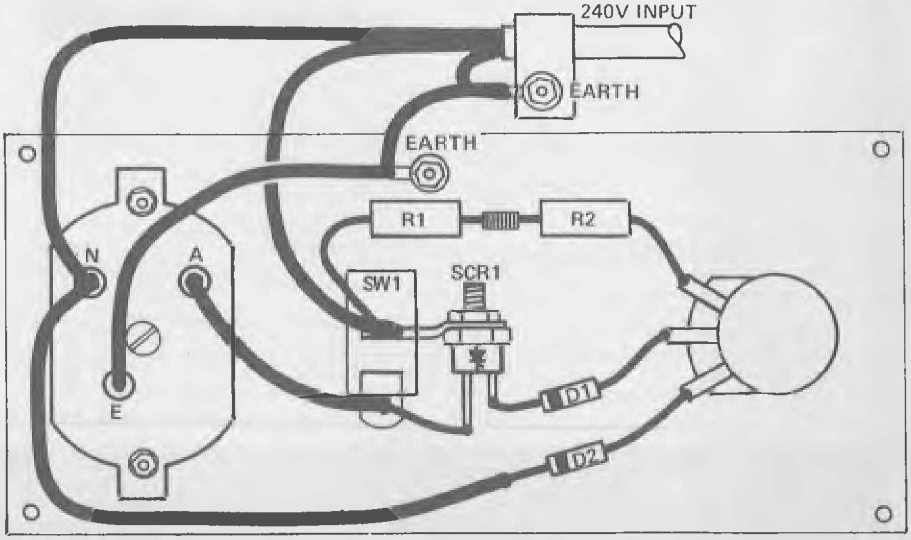


Fig. 2. Component layout – compare this drawing with photograph above.

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DRILL SPEED CONTROLLER

(continued from page 59)

USING THE CONTROLLER

Plug the controller into the mains and the drill into the controller. Select either full speed or variable as required. Note that there is no ON/OFF switch provided on the unit and the normal switch on the drill is used for this purpose. When full speed is selected the drill will run normally and the speed control on the controller will have no effect.

When variable speed is selected, the control will adjust the speed anywhere between zero and about 75% of full speed. There may be a dead zone at both low speed and high speed ends of the control. This is entirely normal and is due to different drill characteristics and component tolerances within the controller.

At very low speeds it may be found the drill runs jerkily under no load. However as load is applied the speed will smooth out.

When using the drill at less than full speed the cooling of the motor will be considerably reduced (as the cooling fan is on the armature shaft and also runs slower). Hence the drill will get hotter when used at low speeds, and extended periods of use in this mode should be avoided. ●

Electronic Windicator

Circuit indicates which of two switches is first depressed.

THIS CIRCUIT was thought up by Mr T. Tuck of Salisbury, South Australia. It's purpose is to indicate which of two switches is first depressed.

The circuit was originally designed for use in a game in which two players on command each try to press their respective switch before the other.

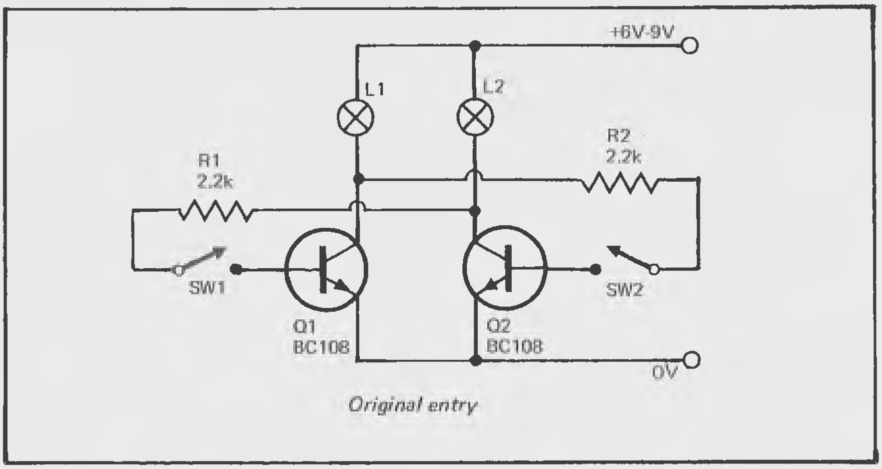
The first to do so causes 'his' globe to light, and providing he keeps his button depressed his opponent cannot cause his own globe to light until the circuit is reset by momentarily breaking the power input or by the winner releasing his button.

With minor modifications, the circuit may be used in quiz games and/or the lights replaced by buzzers (in the latter case diodes should be wired across the buzzers to protect the transistors from voltage spikes generated by the back emf).

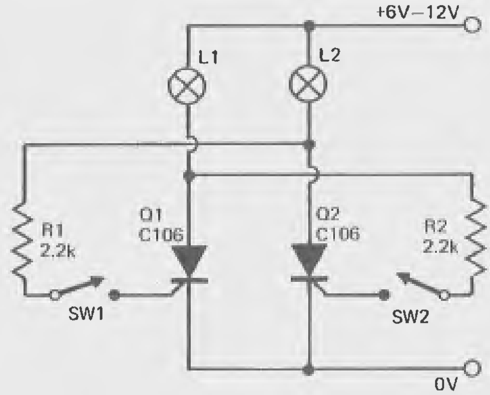
Operating principle is simple. Assume switches SW1 and SW2 are open, both transistors Q1 and Q2 have their bases 'floating' — neither is turned on. Neither globe is alight.

Now assume SW1 is closed. The voltage at the collector of Q2 (which is high) will flow via R1 to Q1's base. Transistor Q1 will now be switched on thus lighting L1. Although SW2 may now be depressed the voltage at Q1's collector is too low to bias on Q2. So L2 cannot be energized.

One disadvantage of the circuit is that it is not self-latching. The winner must keep his button depressed until his opponent has conceded defeat.



Original entry



The circuit is self-latching if the transistors are replaced by SCR's.

SELF-LATCHING

The modification shown here overcomes this disadvantage — at the cost of a slight increase in price.

Basically all that is required is to replace the two BC 108 transistors by two small SCR's. Almost any low current devices will do — C106's for instance. SCR's are self-latching devices so the first globe to be illuminated will stay that way — even though the winner's button is released — until the main power is momentarily broken. ●

HI-POWER

PROJECT 505

Build this high-power strobe for parties, light shows and discotheques.

This high-power strobe light is ideal for use at parties, light shows and discotheques.

It provides a short intense pulse of light adjustable in frequency between one flash per second and twenty flashes per second.

The circuit is unusual in that several strobe lights may be driven from the one basic triggering unit.

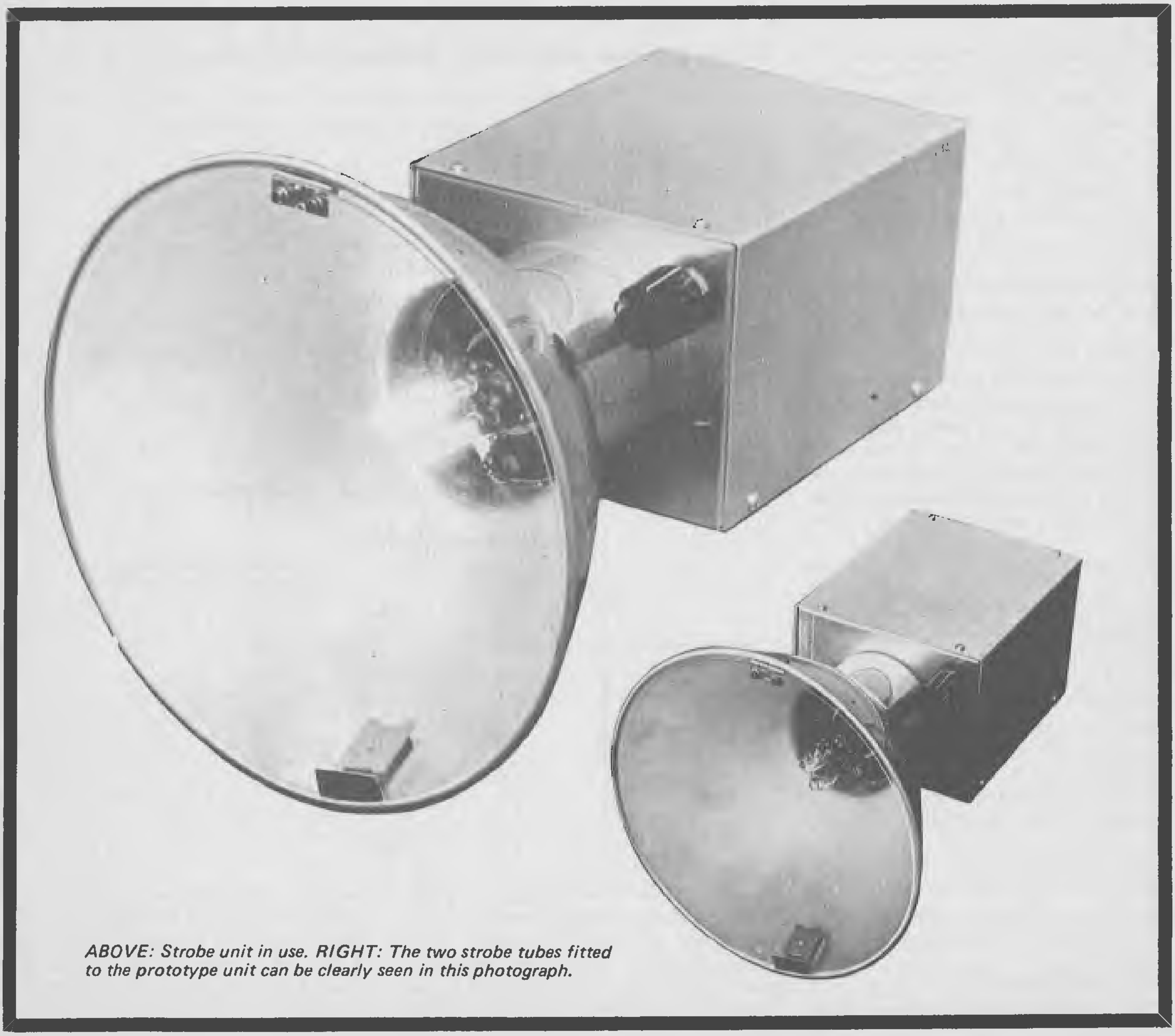
CIRCUIT DESCRIPTION

The circuit of the complete strobe unit is shown in Fig.1.

Diodes D1 to D4 produce positive voltages, at the points marked 'A' and 'B', on alternate half-cycles.

The voltage appearing at point 'A' charges the capacitors C2 and C3, these two capacitors supply the energy for the strobe tube.

Strobe operating frequency is determined by the timing circuit of SCR1, RV1, R2, C1 and LP1/2. Timing capacitor C1 is charged via RV1 and R2 by the positive voltage appearing at point 'B' on alternate half-cycles. When the charge on C1



ABOVE: Strobe unit in use. RIGHT: The two strobe tubes fitted to the prototype unit can be clearly seen in this photograph.

exceeds the break-over voltage of the neons LP1 and LP2, these conduct triggering SCR1.

When SCR1 conducts, the timing capacitor C1 discharges through the primary winding of the pulse transformer (T1) and SCR1.

This causes a high voltage spike to be generated in the secondary winding of the pulse transformer, and it is this spike that triggers the strobe tube into conduction.

Capacitors C2 and C3 discharge practically instantaneously through the strobe tube resulting in a brilliant flash of light. Peak current may exceed 60 amps during this short period.

Since both the timing circuit and the storage capacitors are charged by an unsmoothed half-wave supply, neither can conduct for longer than one half-cycle of supply voltage.

The amount of light produced by the strobe tube during each flash is a function of the capacity of C2 and C3. Increasing the size of these capacitors will increase the amount of light but only at the expense of tube operating life. The capacitors specified will provide several hundred hours operation at a light level adequate for most purposes.

A far more satisfactory way to increasing light output is to fire two or more strobe tubes from the main triggering circuit. This is done by connecting the second and further tubes, additional 220 ohms resistors, and 6.5uf storage capacitors, as indicated by the dotted lines in Fig.1.

No modifications are required to the main timing circuit.

If desired the additional strobe tubes may be mounted within the existing single reflector.

CONSTRUCTION

Our prototype unit was constructed from an aluminium case 5¾" x 4½" x 3½" onto which was mounted a 7" diameter photographic type reflector.

The reflector should be fitted with a perspex cover to protect the tube. A suggested method of locating this cover is shown in Fig.2.

The strobe tube or tubes should be soldered into an octal plug. A corresponding octal socket is housed in the base of the reflector (as shown in Fig.2.) This enables the tube/s to be easily removed for replacement.

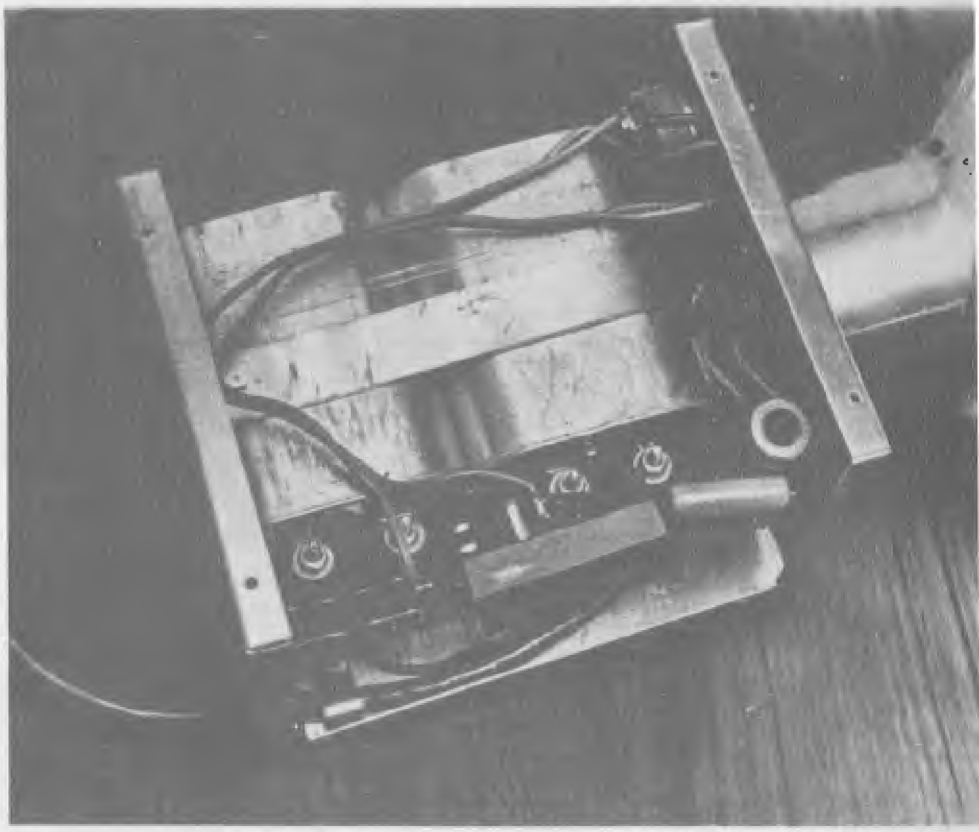


Fig. 5. Construction of the unit — this particular unit has been constructed to drive two flash-tubes. The additional capacitors and 220 ohm, 10 watt resistor referred to in the text can be clearly seen. The pulse transformer is on the extreme right of the matrix board which in turn is bolted securely to the energy storage capacitors.

Since this unit is connected directly to the 240 volt mains, great care must be taken to earth all external metal parts. Unless you are thoroughly conversant with electrical wiring, have the finished unit checked by a licenced electrician.

Component layout is simple and non-critical. Apart from the capacitors and strobe tubes, all components may be mounted on a matrix board or on tag strips.

The storage capacitors are 6.5uf, 250 volt working, paper insulated units of the type used for power factor correction with fluorescent lights. These have been selected for this purpose because they have high discharge current ratings and are readily obtainable at reasonably low cost. This type of capacitor is larger than the electrolytic variety.

If space is critical, electrolytics of the same capacity, but having a 450 volt dc voltage rating, may be used in their place. They will however require replacement at frequent intervals.

If the recommended type of capacitor is used, the matrix board carrying the remaining components can be bolted to these capacitors' terminals, and the capacitors securely located within the metal case.

LOCATE COMPONENTS SECURELY

All components must be fixed rigidly in position so that there is no possibility of their contacting the metal case. If there is the slightest doubt, insulate the component with tape, and line the interior of the metal case with an insulating board.

HI-POWER STROBE

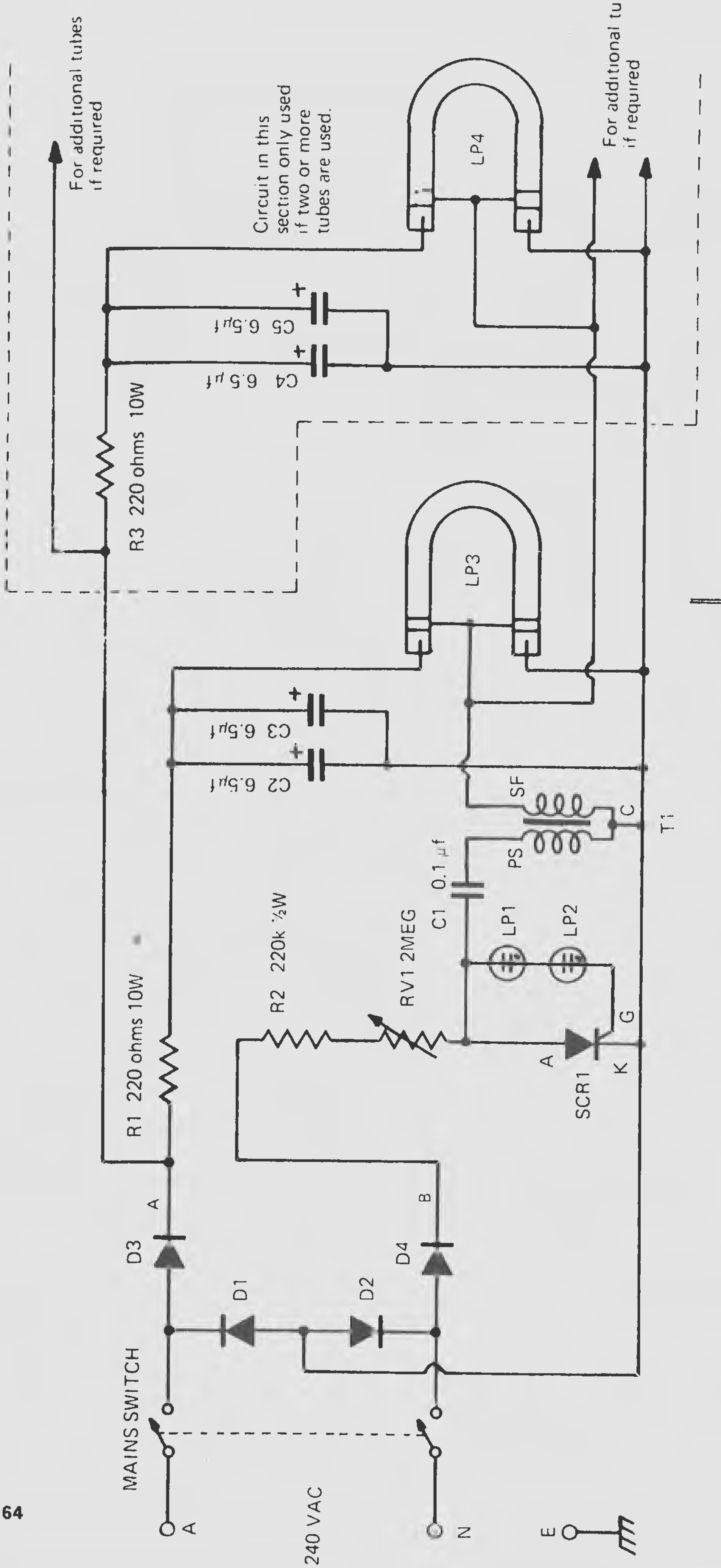
WARNING

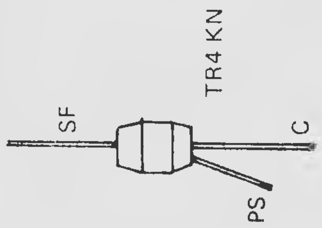
Repetitive pulses of light — especially those occurring at frequencies around nine flashes a second — may cause epileptics to have convulsive seizures.

Those prone to grand mal, petit mal, or psychomotor attacks should avoid areas where strobe lights are used.

In the event of such an attack whilst a strobe is being used, the strobe light must be turned off immediately.

—JV.





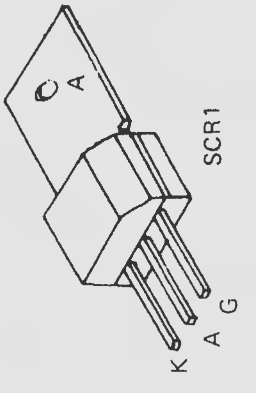


FIG. 1
CIRCUIT DIAGRAM

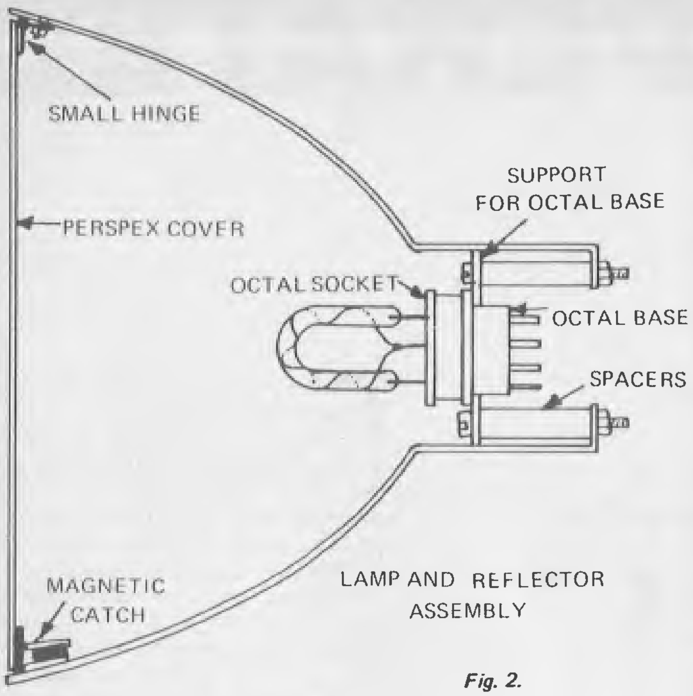


Fig. 2.

PARTS LIST

D1,D2,D3,D4.	silicon diode EM 404 (or equivalent)
R1	resistor 220 ohm, 10 Watt, 10%
R2	resistor 220k, ½ Watt, 10%
R3 *	resistor 220 Ohm, 10 Watt, 10%
RV1	potentiometer, 2 Megohm, linear scale, with double pole switch.
C1	capacitor, 0.1uf, 400V.
C2, C3 **	capacitor 6.5uf, 250 volt ac.
C4, C5 *	as above
LP1, LP2	50 Vdc – neon tube type NE2 or T2
LP3	strobe tube, Circuit Components type MFT 1210.
LP4 *	strobe tube – as above
T1	pulse transformer – Elevam type TR4KN or equivalent
SCR1	Silicon controlled rectifier, C106D, BT100A 500R or equivalent.
Octal plug	McMurdo type L8USP1
Octal socket	McMurdo type RT8
Sundries	reflector, metal box, spacers, perspex cover, hinge, magnetic catch, hook-up wire, three-core flex, nuts, bolts, washers, etc.

** Components marked with one asterisk – only required if two or more strobe tubes are to be used.*

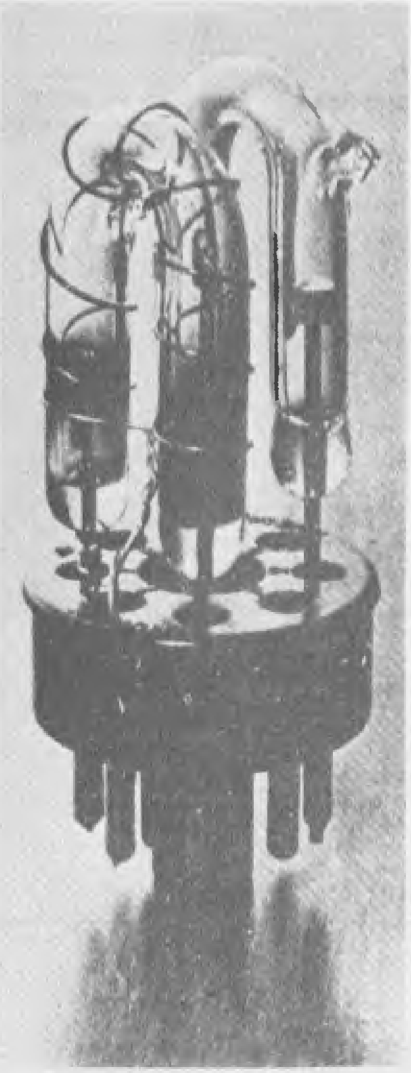
*** If unobtainable from your kit parts supplier, these capacitors can usually be obtained from main electrical dealers handling fluorescent lighting equipment.*

Connect components using 23/0076 240 volt insulated wire. A two-pole mains switch must be used, this may consist of a separately mounted unit, or it can be combined with the main speed-setting potentiometer (a combined switch-potentiometer is specified in the parts list).

The mains cable must be protected by a grommett at the point where it enters the case, it must also be securely attached to the case by a suitable clamp.

A strobe tube which has been found to operate satisfactorily with this project is the Circuit Components type MFT1210. The NE2 neons are available from the same company.

A length of tinned copper wire must be wound around the Circuit Components strobe-tube to act as a triggering lead (Fig.4). ●



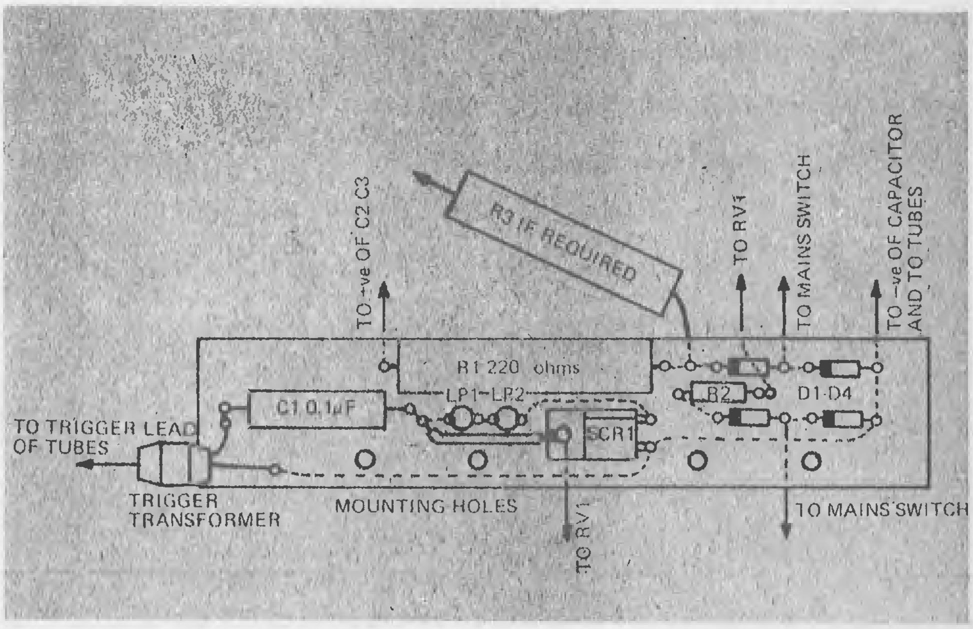


Fig. 4 (left). Two strobe-tubes are shown mounted in one octal holder. A Circuit Components tube is on the left and a now less-generally available tube is on the right. Note that a triggering lead must be attached to the Circuit Components unit. The wire is simply wrapped around the tube as shown.

LIGHT OPERATED SWITCH

This simple light operated switch has many applications.

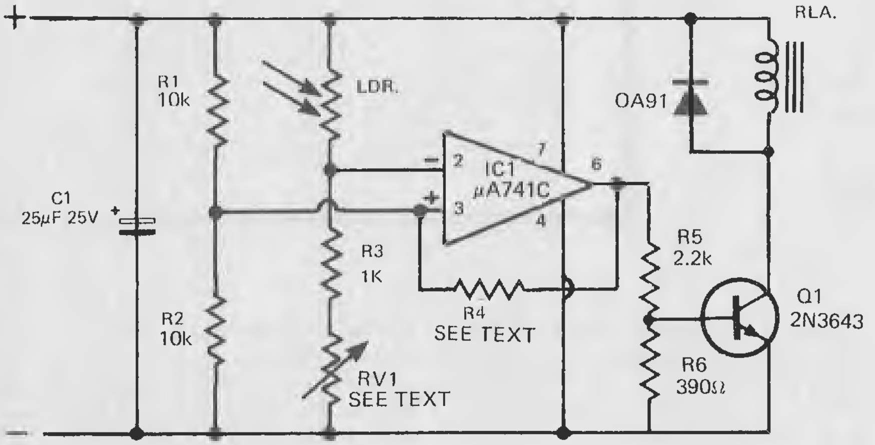


Fig. 1 – Circuit diagram of complete unit.

This is an ideas project as much as a constructional article.

Basically, the circuit shown in Fig. 1 will cause a relay to drop out when light falls onto the light dependent resistor (LDR). Unlike most circuits of this type this unit is very sensitive but also quite stable.

The circuit has many uses including turning on house or vehicle lights at nightfall, acting as a light detector in strong rooms, or with other types of resistive transducers, acting as an accurate temperature control system.

The level at which the circuit operates is set by potentiometer RV1. Resistor R4 determines the level at which the circuit reverts back to the former state. This prevents annoying flickering if the level sensed by the LDR changes very slightly about the set point. The value of R4 should be determined by experiment – values between 4.7k and 2 Megohms may be required depending upon the application.

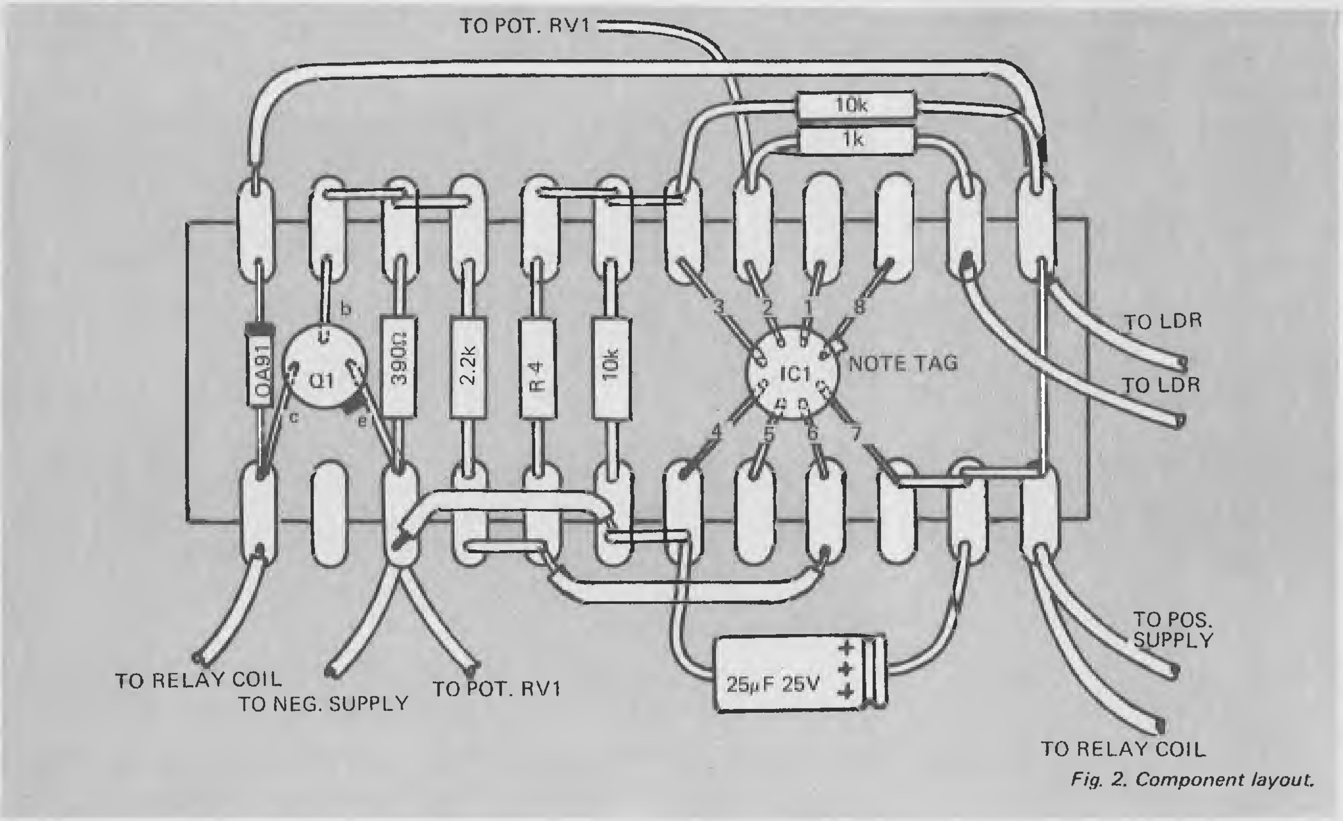


Fig. 2. Component layout.

CONSTRUCTION

The simplest way to assemble the unit is to mount all the major components on tag strips (as shown in Fig. 2). Note that the integrated circuit and transistor shown in Figure 2 are drawn as seen from above.

If the circuit is used with a light dependent resistor, this component must be shielded from any light switched by the unit. If this is not done, the unit will continuously switch the lights on and off.

As shown in Fig. 1 the relay coil is energized when the resistance of the LDR is high (when it is dark). The opposite action may be obtained by reversing the positions of the LDR, R3 and RV1.

The unit may be operated either by a 12 Volt battery, or by the simple mains power supply unit shown in Fig. 3. If the mains supply is used, the 25 µF capacitor shown as C1 in Fig. 1 may be omitted. ●

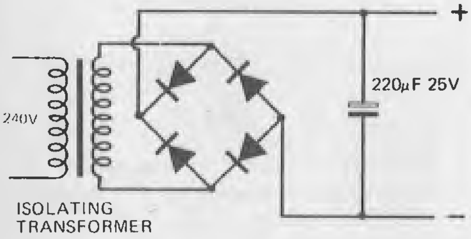


Fig. 3 — Power supply.

PROJECT 304

PARTS LIST ET304

R1	—	resistor, 10k, ½ Watt, 5%
R2	—	" " " " "
R3	—	" 1k " " "
R4	—	resistor, ½ Watt – (see text)
R5	—	" 2.2k, ½ Watt, 5%
R6	—	" 390 ohms " "
RV1	—	potentiometer, – (see text)
C1	—	capacitor, 25µF, 25 Volts electrolytic
IC1	—	integrated circuit, µA 741C
Q1	—	transistor, 2N 3643, TT 3643 or similar.
LDR	—	light dependant resistor, Philips 2322-600-95001 or similar.
D1	—	diode – OA 91 or similar.
RLA	—	relay single or double pole change-over – approx 230 ohm coil, contact rating to suit application.

HOW IT WORKS

Integrated circuit IC1 is connected as a Schmitt trigger, this is a regenerative bistable circuit whose output state depends on the amplitude of the input voltage. Like all bistable circuits, the output has only two possible states, high or low (or on and off).

The input level at which the output goes high is different from the input level at which the output goes low. This difference is used to eliminate the effect of noise and small variations at the input terminals. In the circuit shown here, this difference is adjustable by altering R4.

The Schmitt trigger input is derived from the potential divider formed by the sensor and the potentiometer RV1. The point at which the Schmitt trigger will change state is approximately when the sensor resistance is equal to the setting of the potentiometer. For this reason the value of the potentiometer should be greater than the value of the sensor at its maximum working resistance. If a light dependent resistor is used as a sensor, RV1 should be around 100k.

The value of R4 depends upon the application. If a large differential in operating points is required, the value of R4 should be low (but never less than 4.7k). If a small differential is required then values up to 1 or 2 Megohms may be used.

For LDR operation R4 should be about 22k.

The output of the integrated circuit is directly coupled to an output transistor that in turn operates the relay.

TOP PROJECTS
FROM ELECTRONICS TODAY
VOL 3

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MODERN MAGAZINES (HOLDINGS) LTD
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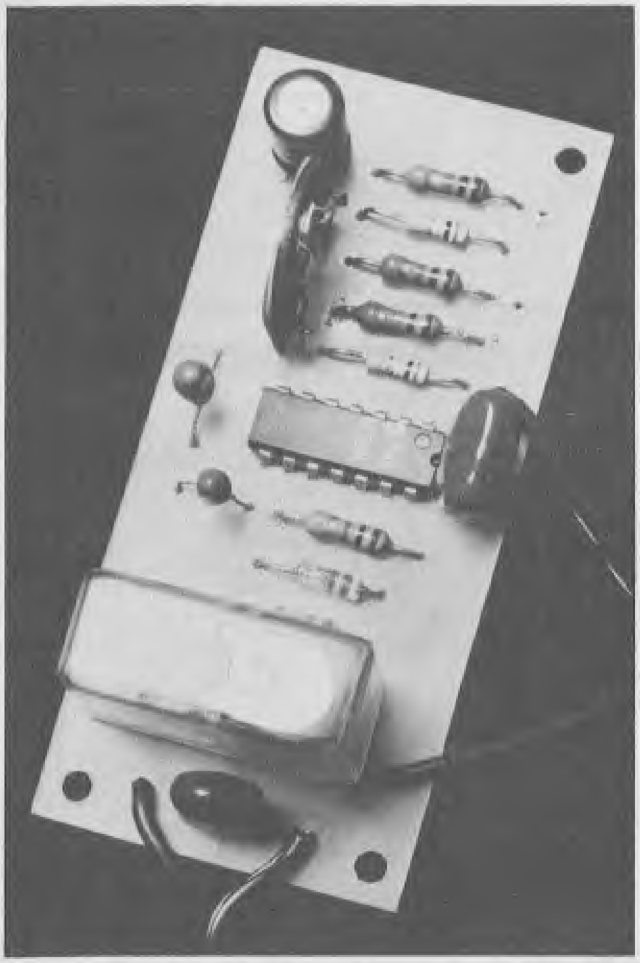
Projected contents
Changes may be made to content if found necessary.

- RADAR ALARM
- CAR ALARM
- TEMPERATURE METER
- ELECTRONIC STOP WATCH
- DIGITAL VOLTMETER
- IMPEDANCE METER
- LINEAR IC TESTER
- COLOUR ORGAN
- ELECTRONIC CROSSOVERS
- GRAPHIC EQUALIZER
- CROSS HATCH GENERATOR
- FREQUENCY METER
- DRILL SPEED CONTROLLER
- NICKEL CADMIUM CHARGER
- DUAL BEAM CRO ADAPTOR
- HOME BURGLAR ALARM

eti PROJECT 313 CAR ALARM



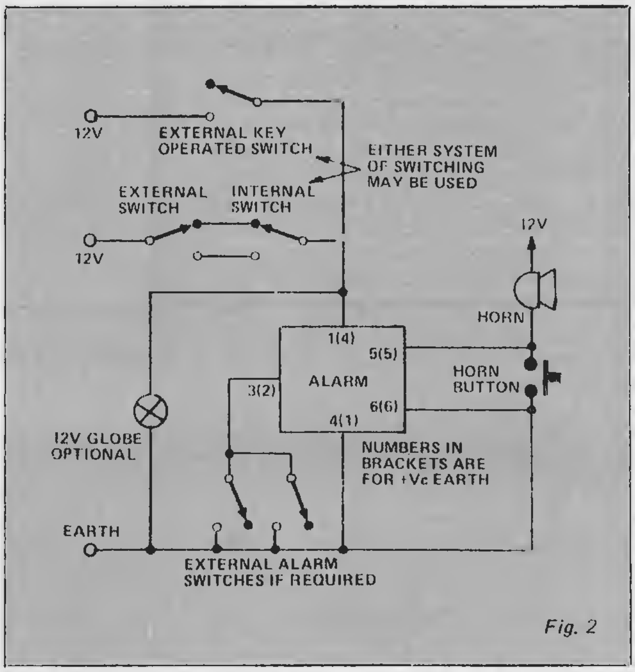

12V
EXTERNAL KEY OPERATED SWITCH
EITHER SYSTEM OF SWITCHING MAY BE USED
EXTERNAL SWITCH
INTERNAL SWITCH
12V
12V
HORN
1(4)
5(5)
ALARM
3(2)
6(6)
4(1)
HORN BUTTON
12V GLOBE OPTIONAL
NUMBERS IN BRACKETS ARE FOR +Vc EARTH
EARTH
EXTERNAL ALARM SWITCHES IF REQUIRED

Fig. 2

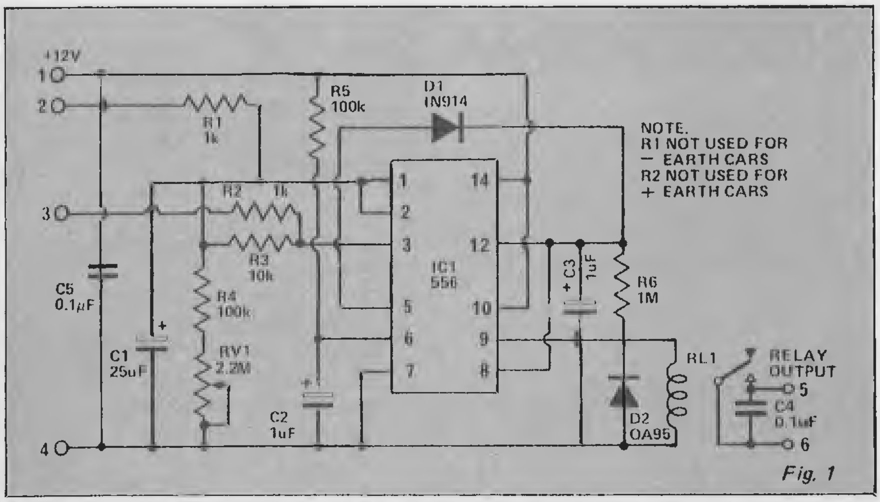
Protect your car with this simple effective circuit.

ONE OF LIFE'S more devastating experiences is to walk out of your house in the morning and find that your car has disappeared!

But this need not happen to you, for an effective alarm system, as described here, may be quite easily constructed and installed at low cost.

The ETI 313 car alarm uses one single IC and a minimum of other components. It will, when actuated, blow the horn at one second intervals, and will continue to do so until deactivated by means of a key switch etc.

The alarm is triggered by any drop in the battery supply voltage caused by an increase in loading on the vehicle's electrical system. Thus, if a door is opened, the interior light will be activated and the increase in electrical load will trigger the alarm.



NOTE.
R1 NOT USED FOR – EARTH CARS
R2 NOT USED FOR + EARTH CARS

Fig. 1

This operating principle simplifies installation, for practically all vehicles have courtesy lights activated by switches on at least two of the doors – and it is a fairly easy task to install further switches on the other doors if required.

Both the boot and under bonnet areas may be protected in a similar manner – indeed many vehicles have lights already fitted in these areas, if not, it is a simple matter to fit them into the circuit such that they come on when the boot lid etc is opened.

These lights are of course very useful apart from their alarm function, but remember – they must operate at all times, not just when the ignition is on.

The alarm is sensitive enough to be activated by anyone pressing the brake pedal – or even by opening the glove box (where a lamp is fitted of course).

The unit is designed for use with cars having 12 volt electrical systems. It may be used with either positive or negative earth systems without modification.

In addition to the power sensing alarm mode other precautions may be taken by adding further alarm microswitches. For example microswitches may be fitted to the suspension such that if anyone tries to lift the car, in order to tow it away, the alarm will go off. If such switches are used they should be connected between terminal 2 or 3 or the alarm (see Fig 1 and 2), depending on whether the vehicle has a positive or negative earth system, and earth.

CONSTRUCTION

Construction of the alarm is extremely simple and anyone capable of using a soldering iron should not have any difficulty. All components, including the relay, are mounted on a small PC board as shown in the component overlay diagram.

Note the polarity of electrolytic capacitors, the IC and diodes. In particular make sure that the germanium diode D2 is mounted in the correct position and with the correct orientation. When soldering use a small, light-weight iron and preferably small gauge solder. Solder quickly and cleanly. Only apply the iron for sufficient time to cause the solder to flow around the joint. These precautions will ensure that components are not damaged by excessive heat. The unit should then be mounted in a small plastic, or metal, box.

Two different switching systems may be used to enable the alarm. Use either an external key switch mounted in a convenient, but not obviously seen location, or a two way system of concealed switches – one inside and one outside. The switch inside is used to enable the alarm (after opening the door) and the external one to disable the alarm before entering the car. This latter system has the advantage that anyone watching will not see where the external disable switch is located.

PARTS LIST – ETI 313

R1,2	Resistor	1k ½watt 10%
R3	"	10k ½watt 10%
R4,5	"	100k ½watt 10%
R6	"	1M ½watt 10%
RV1	Potentiometer	2.2 meg
C1	Capacitor	25μF 25 volt electrolytic
C2,3	"	1μF 25 volt electrolytic
C4,5	"	0.1μF polyester
IC1	Integrated Circuit	NE556
D1	Diode IN914 or similar	
D2	Diode OA95 (must be germanium)	
RL2	Relay 12 volt 280 ohm coil, 6A contacts. Associated Controls type E3201 or similar.	
PC board ETI 313		
SW1	Switch	SPST key operated
SW2,3	"	SPDT toggle (see text)
metal or plastic box to suit.		

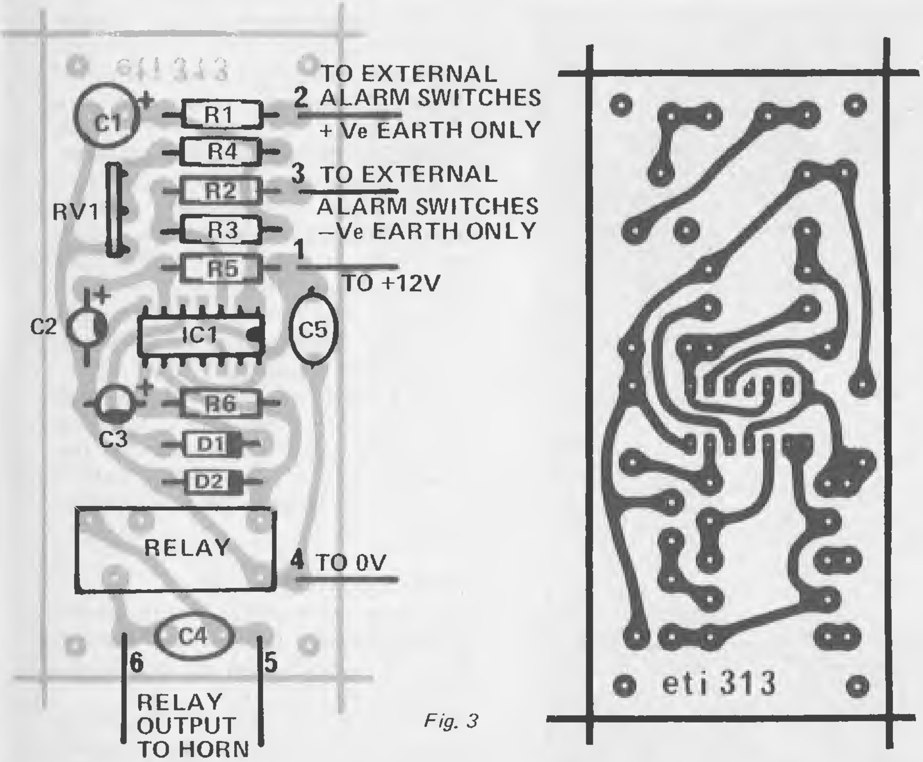


Fig. 3

When this project was originally published, some constructors experienced incorrect ON/OFF timing relay latching.

This may be caused by diode D2 in that, in some cases, it does not adequately limit the reverse voltage generated across the relay This reverse voltage may trigger the IC. This can be cured in one of two ways.

1. Replace diode D2 with an EM401 or similar. Break the track between resistor R6 and diode D2 and place a second EM401 diode across this break such that its cathode and the cathode of diode D2 are together.
2. Add a 200 ohm 1 watt resistor between the +12 volt line and the output (pin 9) of the IC. •

HOW IT WORKS

When a load, especially an incandescent lamp, is switched onto a battery the battery voltage will drop instantaneously and then return to normal. The amplitude and duration of this negative going spike in the supply is dependant on the size of the lamp used but is of sufficient amplitude, even with small globes, to trigger an alarm circuit.

The NE556 IC contains two NE555 timer ICs in a single case. One of the timer sections is used to detect the supply spike and to gate on the second timer which produces a one Hz output to the relay and horn.

Each timer section contains two comparators, a LOW comparator set at 1/3 supply and a HIGH comparator set at 2/3 supply. These comparators set a flip-flop which provides an output.

When the power is first applied, the voltage at pin 6 (input to the low comparator) is initially low for about half a second whilst C2 charges via R5. This sets the output of the flip-flop to a high state where it will remain regardless of further excursion in the voltage at pin 6.

The only way that the output may be set low again is for the input to the high comparator (pin 2) to be taken past its threshold. This threshold voltage is available at pin 3, and by using a voltage divider (R3, R4 and RV1) a slightly lower voltage is derived from it. This is used as a reference level to the HIGH comparator input (pin 2) Capacitor C1 is used to bypass any fast transients which may appear at the input (pin 2).

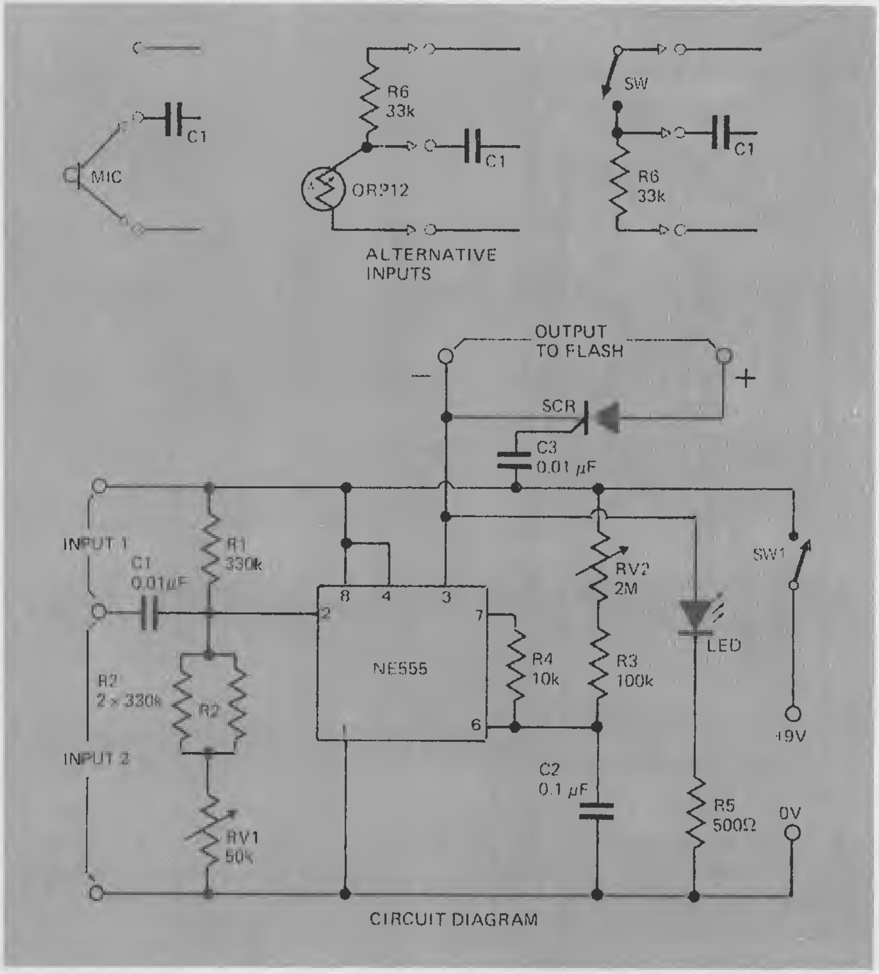
If the supply falls, the voltage on pin 3 will also fall. If it falls below the voltage at pin 2, the output will fall again to a low state and will stay there. The capacitor C1 will also be discharged via pin 1.

The second half of the IC is connected as a free-running multivibrator having a frequency determined by R6 and C3, of about 1 Hz. If the output of the first stage is high, the diode D1 will force the multivibrator to lock into the low state. When the output of the first stage goes low the multivibrator is freed to oscillate.

This one hertz output switches a relay which in turn controls the horn, or any other suitable device. The diodes across the relay prevent reverse voltages being generated which could damage the IC. This must be a germanium type for correct operation.

ELECTRONIC FLASH TRIGGER

Trigger your photo-flash from light, impulse, or sound with this ingeniously simple unit.



MANY sound-operated flash trigger circuits have been published, some of which can be adapted to accept other means of triggering.

This one, designed by Dick Smith/ETI Design Contest entrant, A.T. Torrens of Hornsby, NSW will trigger from virtually any energy source. All that is required is a sound, light flash or other effect that can provide a sudden voltage change.

The unit also incorporates a variable time delay between the trigger input and the flash triggering.

It has been based on the NE 555 timer IC – this has a very sensitive input, the ability to provide the required variable time delay and an output of sufficient energy to trigger an SCR.

CONSTRUCTION

The prototype unit was constructed on Veroboard, taking care not to apply too much heat to either the components or the board.

The most critical part of the circuit is around pin 2 of the IC. The triggering current needed is only 0.5 microamps and with pin 1 being the negative supply line and pin 3 the output, leakage currents across a dirty board can easily cause continuous triggering. To prevent this the strip to which pin 2 is attached should be as short as possible. It is also a good idea to clean off any excess flux with methylated spirits on completion of soldering.

Input is via two miniature phone plugs mounted on an insulating strip. The outside connection goes to the positive and negative lines respectively with the centre connection of both plugs going to the input.

The only problem likely to be experienced is continuous triggering. This is caused by a dirty board. The slightest trace of dampness around pin 2 on the board may cause this trouble.

USING THE UNIT

Sound trigger. The unit may be triggered by a crystal microphone insert or by a loudspeaker used as a microphone. The input can be to input 1 or 2. When the sensitivity is turned up to maximum, (RV1 at minimum) the unit may trigger continuously. To avoid this, simply turn the control back until the LED goes out, but flashes when the required sound is made. The photo of the tennis ball hitting a stool was made in this way with the time delay at minimum (about 4 milliseconds).

Light trigger. The resistance change of a cadmium sulphide cell may be used to trigger the unit when the light level falling on the cell varies. If the intensity of light increases, the resistance drops rapidly, while if the intensity falls, the resistance increases — but much more slowly. Triggering is thus best done by increasing the light level. Connect the CdS cell to input 2 via a 33 k resistor across input 1. A sudden increase in the light level will then fire the flash. If the time is set at a minimum this can be used as a slave flash unit as it only responds to sudden changes.

The photos of the fluid drop falling into the beaker of water were taken by having the drops interrupt a light beam falling onto a cadmium sulphide cell. The cell is in the tube in the top left of the large photo. The drops were indian ink to be certain they would block out the light beam. The time delay was about 250 milliseconds.

Switch triggering. With a switch connected to input 1 and a resistor to input 2 (33 k), the unit will fire when the switch is opened. If the position of the switch and resistor are interchanged the unit will fire as the switch is closed.

For simplicity in use the inputs have been devised using miniature phone sockets with a resistor connected to a plug — so by simply changing the plugs the input can be changed. ●

HOW IT WORKS

A negative pulse at the input is fed via capacitor C1 to the input pin (2) of the IC. Pin 2 is held slightly above its triggering voltage of 1/3 V_{cc} by the voltage divider comprising R1, R2, and RV1. The negative pulse triggers the IC and the output (pin 3) goes high for a time period controlled by RV2, R3 and C2. When the output goes low again at the end of the time interval capacitor C3 charges through the gate cathode circuit of the SCR switching it on and firing the flash.

Capacitor C1 isolates the input from the voltage divider so that the unit isn't sensitive to the dc level at the input. RV1 acts as a sensitivity control by allowing the voltage to be adjusted to a suitable level so that the input signal will trigger the IC. Resistor R4 limits the discharge current from C2 at the end of the timing cycle so protecting the IC. The LED and its protective resistor R5 act as an indicator to show that the unit has triggered, so simplifying the setting up process and minimising the number of times the flash has to be fired. This means that the flashgun needn't be fired until a photo is to be taken.

PARTS LIST

SEMICONDUCTORS

IC	NE 555.
SCR	C106 D1 or similar with a 400 volt rating
LED	Miniature red.

RESISTORS (10%0

R1	330 k
R2	165 k (2x330 k in parallel)
R3	100 k
R4	10 k
R5	560 ohm
R6	33 k (optional depending on input)

CAPACITORS

C1	0.01 μF
C2	0.1 μF
C3	0.01μF

SWITCH

Any SPST switch suitable

POTENTIOMETER

RV2	2 Meg linear
RV1	50 k linear

INPUT DEVICE

CdS cell (ORP 12)
Crystal mike insert etc.

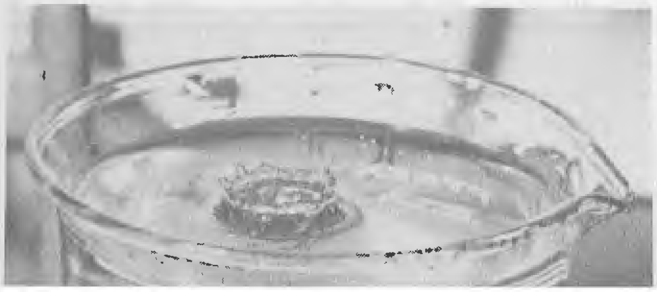
OUTPUT DEVICE

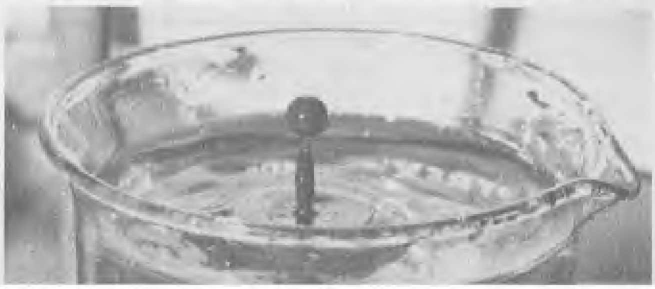
Electronic flashgun, preferably computer type as these give a much shorter flash duration at close range.

OTHER PARTS

Metal case (58 x 58 x 100 mm)
Veroboard (40 x 80 mm)
Input sockets minute phone.
Output to suit flash unit being used
Knobs 2 for pots.
Battery Connector.

Drops of Indian ink are 'caught' here splashing into a beaker.





PROJECT 236

CODE PRACTICE OSCILLATOR

Essential equipment for gaining Novice Licence

NOW THAT the Novice Licence has finally been introduced, many young readers will want to learn the Morse Code. This is so because one of the Novice Licence requirements is the ability to send and receive Morse at the rate of five words per minute.

The first step in learning Morse is to obtain a means of practicing the code and the ETI 236 Code-practice set is specifically designed for that purpose. It may be used for practicing alone or with a friend. Practice with a friend is strongly advised as it is not much use knowing the code but transmitting it in a way that no-one else can understand.

An excellent way of learning is to purchase the "Archer" code record or cassette. These are available from any Tandy store and take you step by step through from simple character-code groups and gradually extends to include all characters. Both tape and record offer speeds of from 7 to 15 words per minute and, of course, these speeds will be entirely adequate to obtain the requisite 5 words-per-minute.

An important aid to learning is to memorise the way a code group sounds. For example the letter A is represented by the code group •▬, this should be learned as the rhythmic sound didah – not as dot dash, or even as dit dah!

Finally there is no substitute for practice. Try to do at least half an hour to an hour a day. Don't worry about speed, this will come naturally, concentrate mainly on accuracy.

CONSTRUCTION

The oscillator is built onto one section of the ETI experimenter board as shown in the component overlay diagram. (This board is shown in detail on page 75 of this book). Take particular care to correctly orientate the IC, the electrolytic capacitor and the diode. The whole unit was built into a 100 x 165 x 300 mm plastic box which had an aluminium lid. Almost any box will do of course, but make sure that it is large enough to house the speaker you intend to use. We mounted our small 50 mm speaker to the back of the aluminium front panel.

Drill holes in the end of the box, for J1, 2 and 3, and fit them. Drill holes to mount the speaker, the phone and tape sockets and RV1 on the front panel. Note that we used two of the screws which secured the speaker to also secure the printed circuit board and that some holes must be provided for the sound from the speaker. Mount the components to the front panel and the printed circuit board and interconnect them as shown in Fig. 2. Note that the aluminium panel is connected to zero volts via the phone socket, the tape socket and the screw supporting the board, and that this screw is part of the connection between pin one of IC1 and zero volts. The battery is held into the bottom of the box by a piece of adhesive tape.

Practically any speaker may be used that fits your box. It is recommended, however, that 3 or 4 ohm speakers not be used unless the supply battery is changed to 6 volts instead of 9 thus not exceeding the output stage rating of the IC.

The International Morse Code.

A	•▬	N	▬•	1	•▬▬▬▬	=	▬•••▬
B	▬•••	O	▬▬▬	2	••▬▬▬	:	▬▬▬•••
C	▬•▬•	P	•▬▬•	3	•••▬▬	;	▬•▬•▬•
D	▬••	Q	▬▬•▬	4	••••▬	( )	▬•▬▬•▬
E	•	R	•▬•	5	•••••	/	▬••▬•
F	••▬•	S	•••	6	▬••••	Error	••••••••
G	▬▬•	T	▬	7	▬▬•••	Wait	•▬•••
H	••••	U	••▬	8	▬▬▬••	End of message	
I	••	V	•••▬	9	▬▬▬▬•		•▬•▬•
J	•▬▬▬	W	•▬▬	0	▬▬▬▬▬	Invitation to transmit	
K	▬•▬	X	▬••▬	.	•▬•▬•▬		▬•▬
L	•▬••	Y	▬•▬▬	,	▬▬••▬▬	End of work	
M	▬▬	Z	▬▬••	?	••▬▬••		•••▬•▬

HOW IT WORKS – ETI 236

The oscillator is constructed around a 555 integrated-circuit timing chip. To better understand how we make this chip oscillate we must refer to the block diagram of the chip, Fig. 3. The two circuit blocks labelled as comparators each give either full output or zero output depending on which of the two inputs is greater than the other.

One of the inputs of each comparator in the 555 is connected to a voltage divider consisting of 3 equal-value resistors, connected in series between Vcc and zero volts. Thus when the voltage at pin 2 rises, so that it exceeds one third of Vcc, comparator 1 will change state. Likewise comparator 2 will change state when the voltage at pin 6 rises above two thirds of Vcc. The outputs of both comparators will of course revert to their original states when the voltages at pins 2 and 6 fall below the thresholds set by the divider chain.

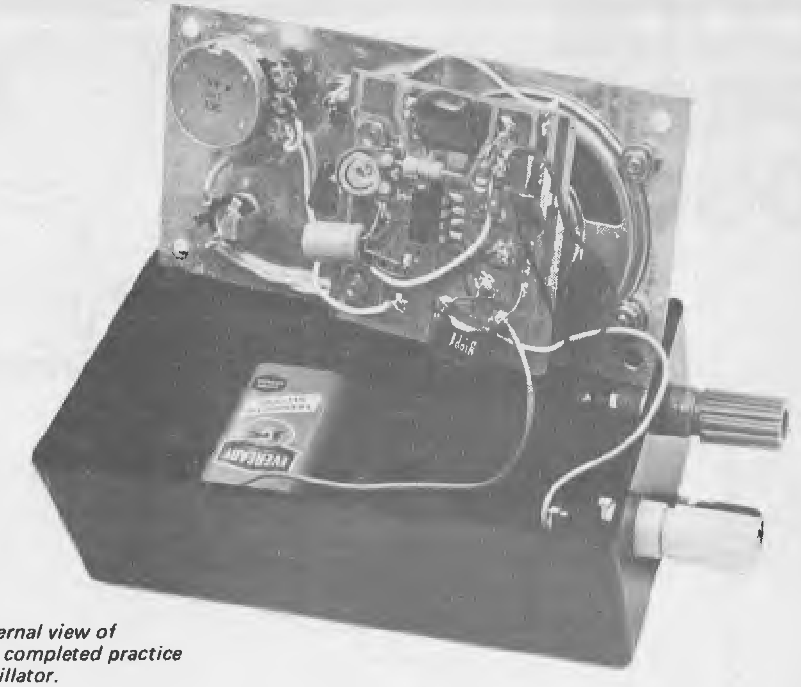
Both comparator outputs are fed to a flip flop which is forced into one state when the voltage at pin 2 falls below 1/3 Vcc and into the other state when the voltage on pin 6 rises above 2/3 Vcc. The output of the flip flop drives both a transistor and a high-level output stage in such a way that the transistor is turned off when the voltage at pin 2 is below 1/3 of Vcc. and on only when the voltage at pin 6 exceeds 2/3 of Vcc.

In our oscillator pin 2 and 6 are connected together and to capacitor C3 which charges via RV2, R3 and R2. When the voltage across C3 goes above 2/3 Vcc comparator 2 and the flip flop will change state turning on the discharge transistor. Capacitor C3 will be discharged (via RV2, R3 and pin 7) and when its voltage falls below 1/3 Vcc comparator I will change the state of the flip flop turning off the discharge transistor thus allowing C3 to charge again.

Thus the voltage across C3 will alternate between 1/3 and 2/3 Vcc with a frequency which depends on the values of RV2, R3, R2 and C3. With each change in state of the flip flop the output stage also changes state and since this is a relatively high current output we can extract sufficient power to drive a loudspeaker directly. Volume is controlled by RV1 and a phono socket is provided for private headphone listening.

Capacitor C2 provides filtering for the reference divider via pin 5 and an output for a tape recorder is taken from pin 7 and filtered and attenuated by R4 and C5 to produce a sawtooth output. Diode D1 is used to protect the oscillator from reversed battery connections when the unit is connected to other units operating on different supply voltages over a two wire circuit. If you intend to use your oscillator by itself only D1 may be omitted.

The Morse key is a normally-off switch. When it is pressed the Vcc circuit is completed and the oscillator functions. An ON/OFF switch is not included as power is only drawn when the Morse key is depressed.



Internal view of the completed practice oscillator.

PARTS LIST – ETI 236

R1	Resistor	10ohm	½W	5%
R2	"	10k	"	"
R3	"	33k	"	"
R4	"	390k	"	"

RV1 Potentiometer 2.2k
RV2 Potentiometer 50k trim type

C1	Capacitor	10μF 16 volt	electrolytic
C2	"	0.1μF	polyester
C3	"	0.022μF	polyester
C4	"	0.1 μF	"
C5	"	0.033μF	"

D1 Diode EM401 or similar

IC1 Integrated Circuit NE555

Speaker 50 or 75 mm 8 ohm (to suit case).

J1,2,3 Binding posts 3 mm. RCA tape socket, 3mm jack socket, 9 volt battery, box to suit.

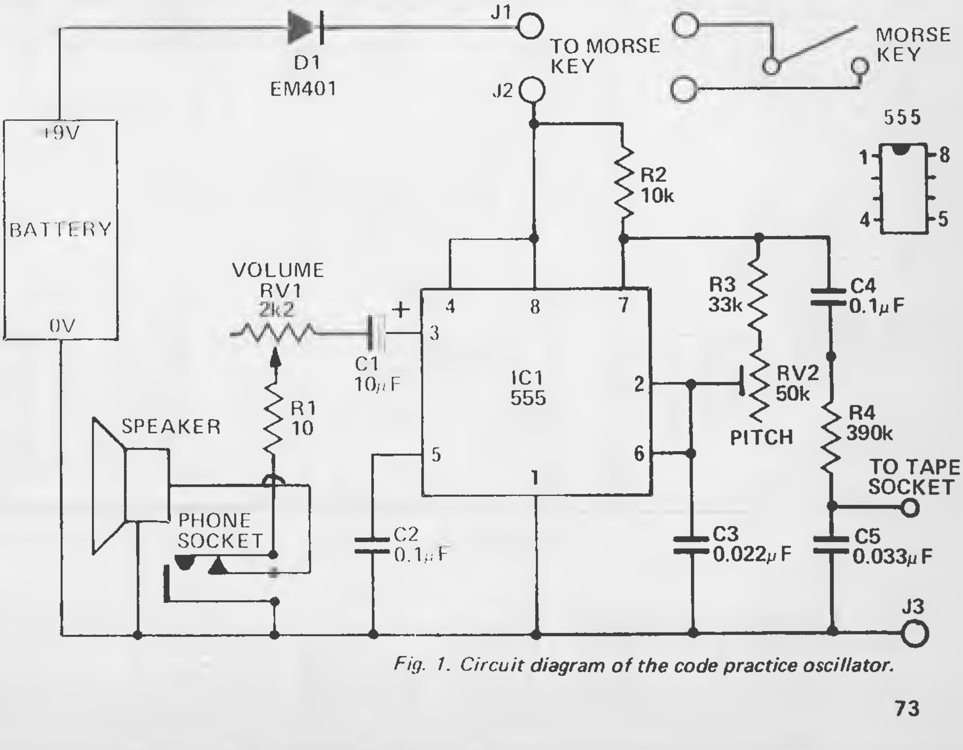


Fig. 1. Circuit diagram of the code practice oscillator.

CODE PRACTICE OSCILLATOR

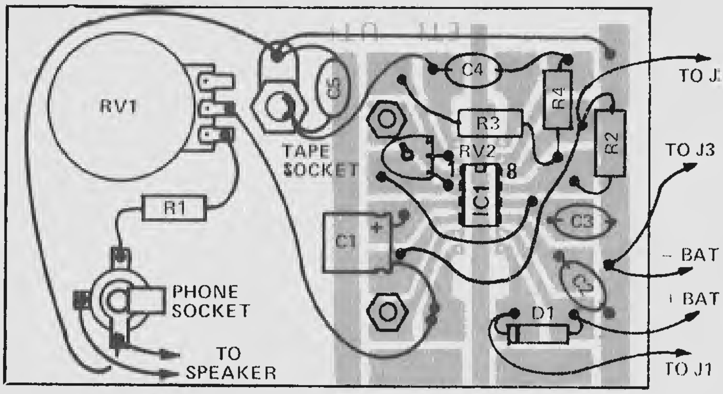


Fig. 2. Component overlay and interconnections.

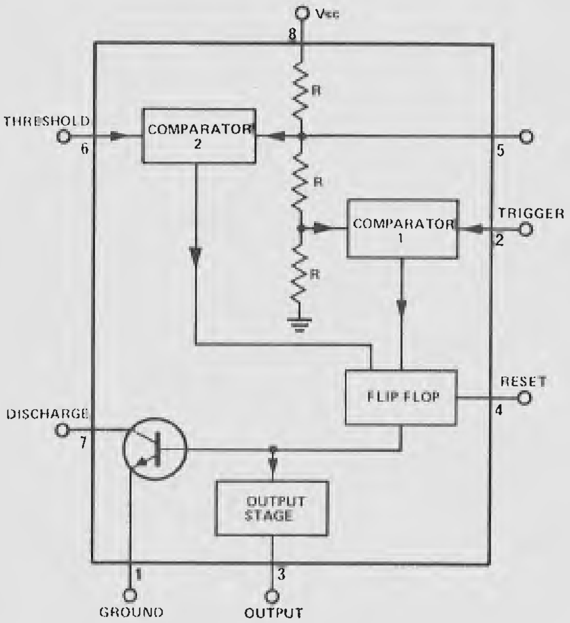


Fig. 3. Internal arrangement of the NE 555 timer IC.

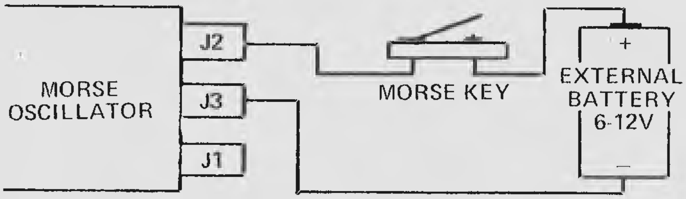


Fig. 4. Method of connecting an external battery to operate the oscillator.

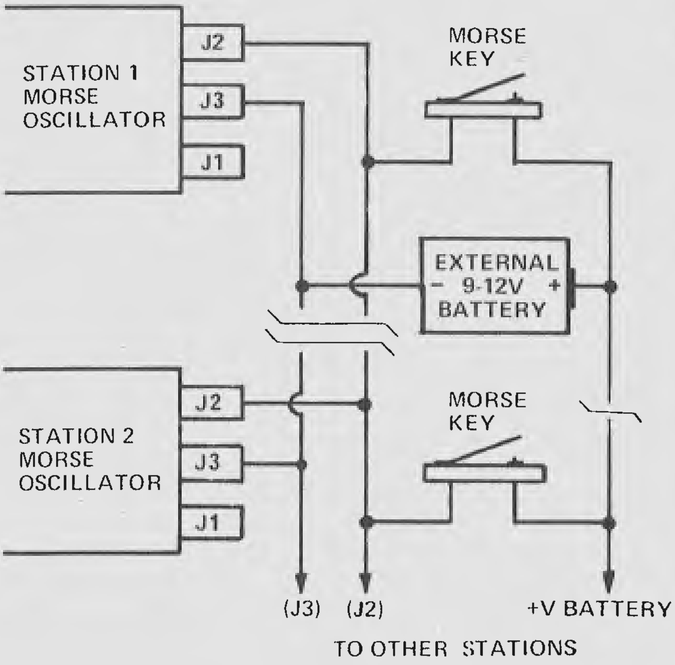


Fig. 5. For two way communication with a friend two oscillators are required connected as shown.

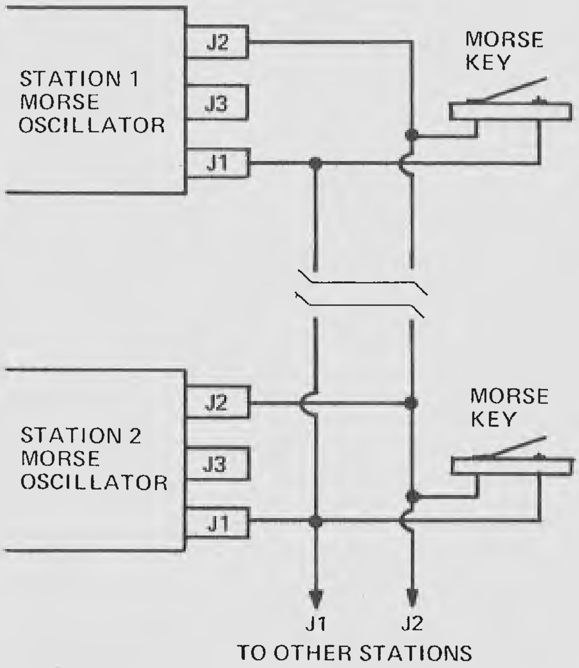
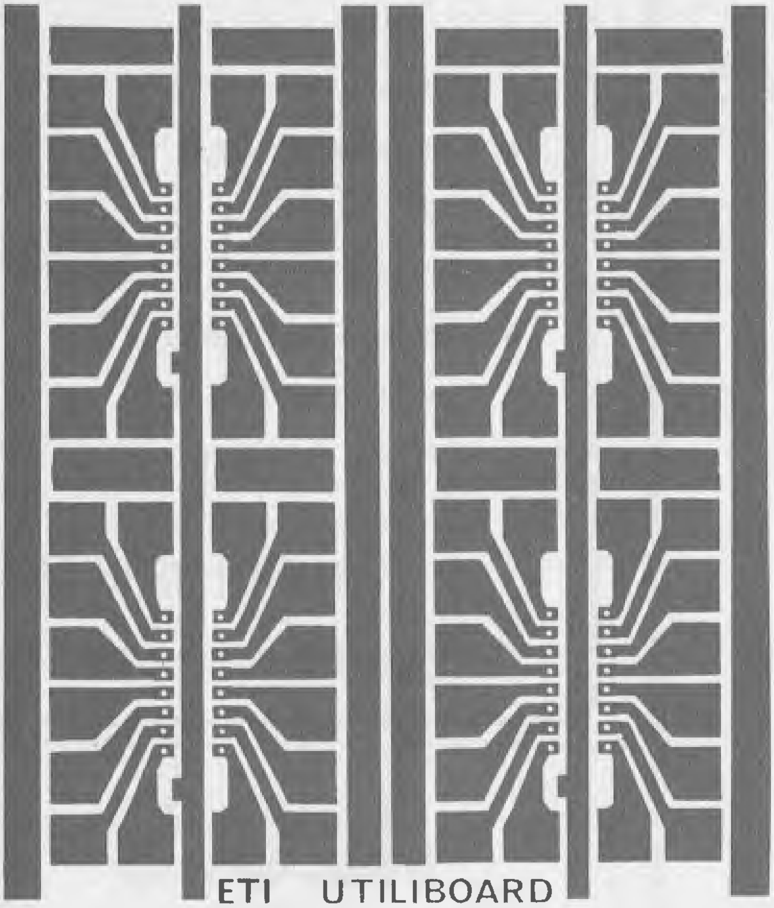


Fig. 6. Two way communication system using an external battery.

ETI UTILIBOARD



A versatile board for experimenters.

THE CONSTRUCTION of any project is always simplified by the use of a proper printed-circuit board. The neat and tidy appearance of a well made printed-circuit board, full of components, gives a professional look and is most satisfying. There are however some drawbacks. Each design requires a different board and you need a reasonable degree of knowhow and time to make your own boards.

Quite often it may be felt that the cost of a ready made printed circuit board, for a simple project, is unwarranted or it is just too much of a hassle to make a trip half-way across a city to obtain one.

There are several alternatives, such as Veroboard and Matrix board, and many people are now using specially designed general purpose boards which are specifically made for versatility in the construction of general circuitry.

This latter approach has several advantages. The finished board looks neat and professional, fairly-complex circuits can be quickly assembled, and the large pads available allow experimental circuits to be debugged with ease. Such boards allow the builder to change the circuit of a particular project to suit his personal needs or, to use physically-larger components (eg junk-box parts) than those specified.

There are many of these boards available but many of them are quite expensive and some are lacking in versatility. Hence we decided to design our own board for use in simple projects. We have in fact used the board for the code-practice oscillator described in the previous article.

USING THE UTILIBOARD

On conventional printed-circuit boards the components are always mounted on the non-copper side of the board and all our previous overlays have shown components in this way. However in experimental circuits it is more convenient to mount the components on the copper side. This allows components to be added, or shifted, without having to continually turn the board over. The code-practice oscillator is in fact built this way.

Note that the board consists of four individual 16-pin dual-in-line IC pad-groups, each pin of which has associated with it a large pad to which several component leads can be soldered without the need for holes.

The broad lines through the centre of the pads, and on either side, are suitable for supply or earth connections. They are continuous so that the group of pads can be used together or the board may be sawn up into single or 2-way sections as required.

The broad line up the centre has indicator marks which point to pin I of an IC when it is mounted on the non-copper side of the board and the dot marker on the IC points to indicator-mark end of the board. Note that this central line is broad enough so that individual pads may be connected to it by solder bridging.

Of course any of eight, 14 or 16 pin DIL IC's can be mounted as required, or, discrete transistors may be inserted into appropriate holes. You will find this board extremely versatile and easy to use. ●

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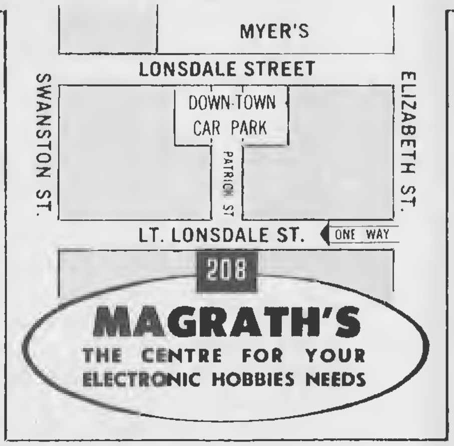

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TRANSISTOR TESTER

PROJECT 222

Measure and test your transistors with this easily built device.

EXPERIMENTERS will frequently use the same transistors in a whole sequence of experimental circuits, for recovering and re-using such components saves considerable outlay.

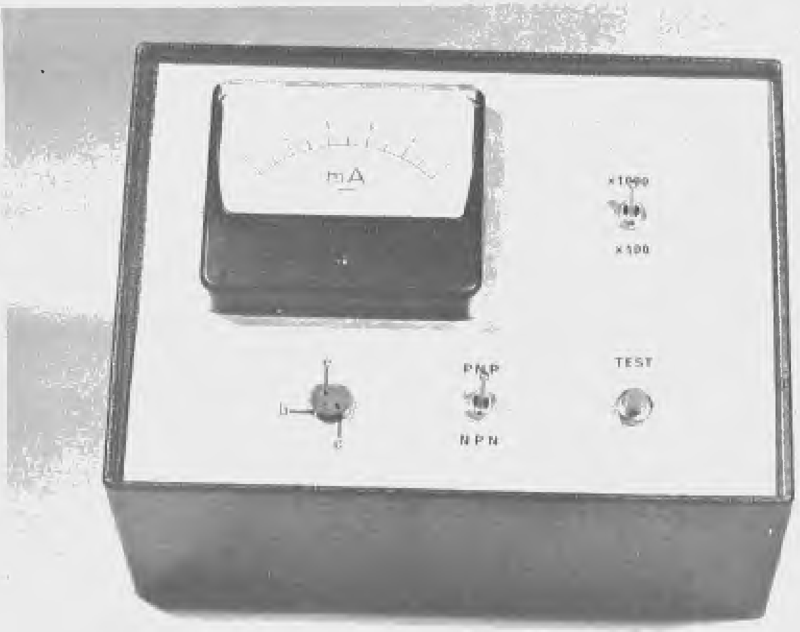
But semiconductors are easily damaged — by incorrect operating conditions — or by excessive application of heat when soldering.

Only too often a malfunctioning experimental circuit will be checked and rechecked before one realises that a transistor is dead.

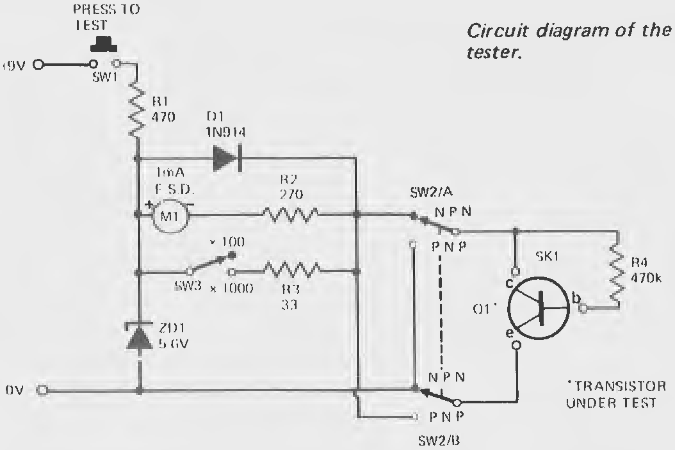
A transistor tester will save hours of such frustrating and unproductive effort.

Transistors can often be bought cheaply in bulk — usually in unmarked and untested lots — or recovered from old computer boards. Here again a transistor tester will prove invaluable in eliminating the faulty bits.

The simple transistor tester described in this project not only sorts out the good from the bad but indicates also the approximate gain (β) of the transistor. This is a most useful feature for those circuits where transistors need to be matched. Two ranges of gain (beta) are provided, 0-100, and 0-1000. The tester may also be used to check transistor polarity. ●



The transistor tester mounted in a metal case.



Circuit diagram of the ETI transistor tester.

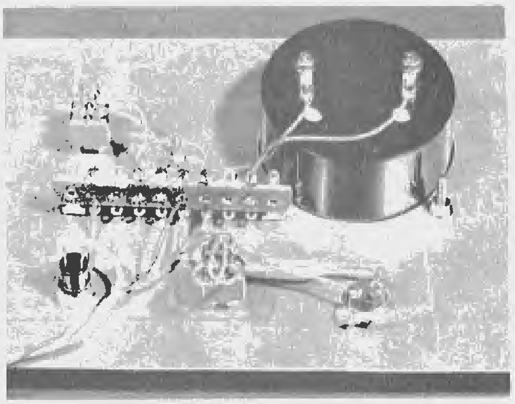
PARTS LIST — Transistor Tester — ETI 222

R3 Resistor 33Ω ½ watt 5%
R2 Resistor 270Ω ½ watt 5%
R1 Resistor 470Ω ½ watt 5%
R4 Resistor 470k ½ watt 5%
D1 Diode IN914
ZD1 Zener diode BZY88C5V6
SW1 Push button push-to-make
SW2 Switch toggle DPST
SW3 Switch toggle SPST
9V battery
M1 Meter 1mA movement
SK1 Socket T05 transistor type
Metal case or minibox

HOW IT WORKS

Operation of the tester is very simple. The meter, M1, monitors the collector current of the transistor under test whilst R4 supplies a current of about 10 μA into the base of the test transistor. Thus, on the 100β range, the maximum collector current will be 1 mA and, on the 1000β range, 10 mA. Switch SW3 therefore changes the meter sensitivity according to the beta range selected.

The meter is protected by means of D1 against damage due to test transistors being shorted. The zener diode ZD1 stabilizes the battery voltage to 5.6V.



The construction method may readily be seen from this photograph of the back of the front panel.

CANNIBALS and MISSIONARIES

— the final river crossing problem

Designed by A.J. LOWE

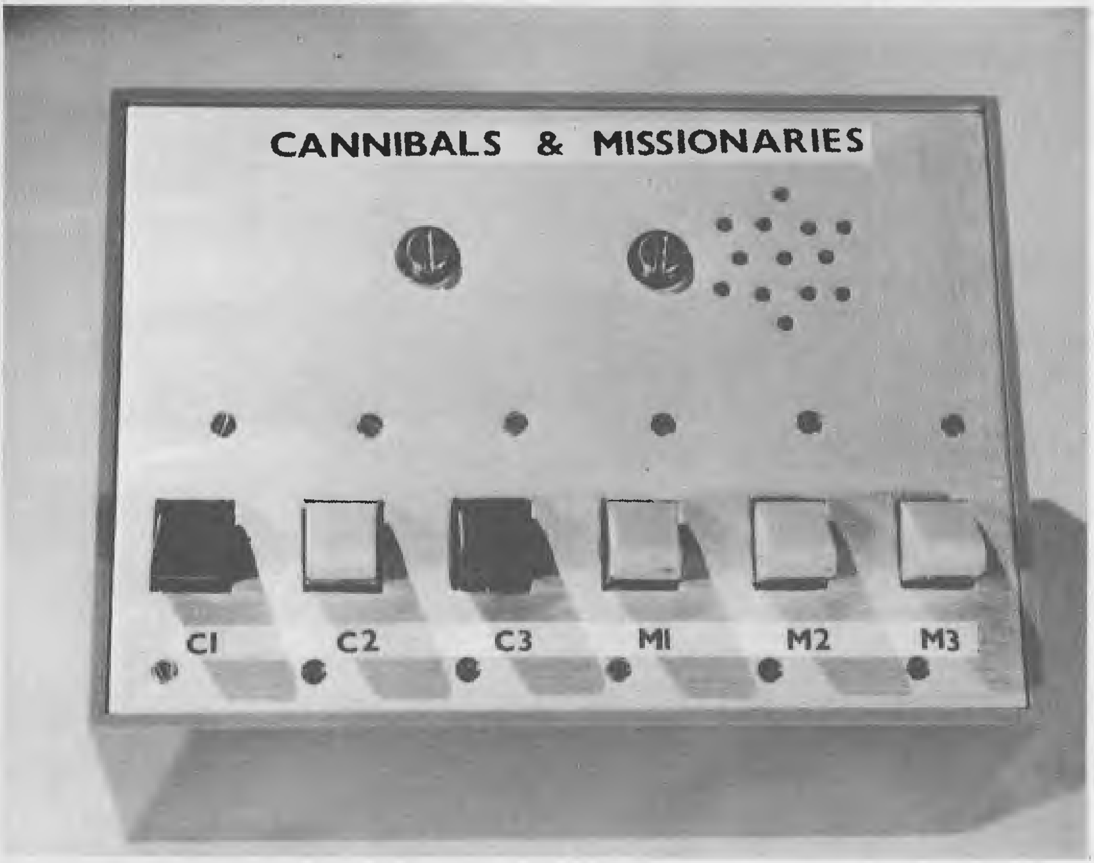


Fig. 1 The finished model. Lettering done with press-on letters on white Contact.

HERE'S a particularly perplexing problem provided for people with painstaking propensities. It's an electrical model of the puzzle which goes like this:

Three missionaries and three cannibals come to a river they want to cross. A little boat at the bank will carry only two people. All the missionaries can row, but only one of the cannibals can row — he'd been to Oxford. He also wears a white shirt! If at any time, on either side of the river, cannibals outnumber missionaries then the cannibals will eat the missionaries, which, understandably, the missionaries don't want. Problem: how do they cross safely?

In the model shown in Fig.1 the missionaries are represented by three switches M1, M2 and M3, and the cannibals by three switches C1, C2 and C3. The missionary switches have yellow levers. Two of the cannibal switches have black levers, but the switch representing the cannibal who wears a shirt and learned to row at Oxford — C2, has a white lever.

By operating the switches to represent crossings of the people involved — never more than two at a time as that's the limit of the boat, you try to solve the problem. If at any time a situation arises where, on either bank, cannibals outnumber missionaries then an alarm sounds and you've failed.

The circuitry detects situations where cannibals can satisfy their taste for eating missionaries, but it does not detect cheating — such as putting three people in the boat, or allowing a cannibal who can't row to be in the boat on his own.

CONSTRUCTION

The prototype was assembled in a plastic box 140 mm x 100 mm x 75 mm high with an aluminium front panel. Modern telephone-type key switches were used each having four changeover switches on each side of the switch.

Figure 3 shows the bottom view of one of the switches and how its terminals are laid out. It also shows, by means of the arrow-headed lines, which terminals connect with the moving parts of the switches. The eight changeover switches which comprise one key switch have been lettered a to h for convenience and to tie in with the lettering in Fig.2.

Note carefully that the switches in Fig. 3 are shown making the circuits which they make when the switch lever is in its *central* position. When the switch lever is moved from the central position to the start side of the river it changes over only the switches on the opposite half of the switch — i.e. switched a, b, c, d. When the switch lever is moved from the centre position to the far side of the river it changes over only switches e, f, g, h.

These key switches can be bought with push-on handle covers of various colours. The prototype used yellow covers for the missionaries, black for two of the cannibals, and white for the cannibal C2 who wore a shirt (and went to Oxford).

Although key switches each containing a total of eight changeover switches were used in the original, actually it is only the missionaries who need all eight switches. The cannibals need only five changeovers, but it was thought simpler to buy six identical switches.

Those with access to disposal stores could probably buy enough old style key switches comparatively cheaply, to build up the necessary number of switching functions needed.

The panel aperture dimensions for a standard key switch are shown in Fig.4.

The buzzer alarm and battery holder are all one piece — taken from a bicycle horn.

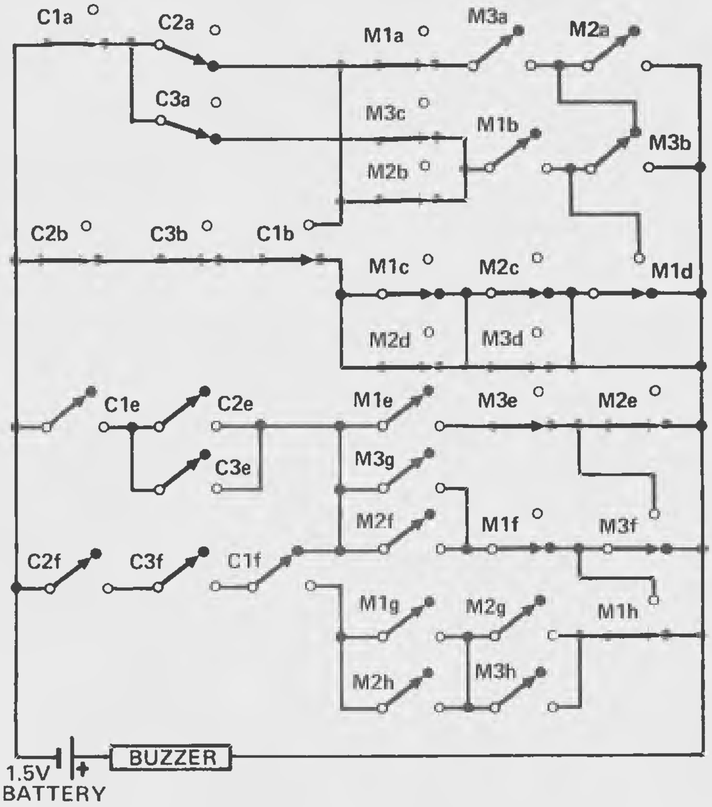
Wiring must be done carefully — very carefully! Bare wire was used in the prototype. Figure 5 shows the wiring diagram for the start side half of the switches and Fig. 6 shows the wiring of the other half. They are shown separately to minimise confusion. As can be seen from Figure 7, the switch wiring needs considerable care. On each of Fig. 5 and Fig. 6 one lead is marked 'To Buzzer' and another 'To battery —ve'. These leads, i.e. both buzzer leads are joined together and to the buzzer; and both battery —ve leads are joined together and run to battery —ve.

When wiring up — work logically. Start with switch M3 which is on the left when the panel is upside down. Start with the top left hand terminal and make all connections to it. Then move down each terminal in turn down the left hand row of terminals. Proceed row by row to the right making and checking connections to each terminal. It's a good idea to cross off with a pencil, each connection shown on the wiring diagrams, as soon as that connection has been made on the switches. Be sure not to miss the short connection between switches M3e and M3f.

If you want to check through the wiring diagrams, the circuit, and the switch diagram — bear in mind that the switch diagram shows connections with the switch lever in the central position, and the circuit diagram shows the connections with the levers in the start side position.

On completion of the wiring and after insertion of the cell, the puzzle should work. Check out all the alarm

Fig. 2 The circuit diagram with all switches shown with levers on the start side of the river



HOW IT WORKS

The circuit is a switching logic circuit. See Fig. 2. The cell and buzzer are between the outer vertical rails, and if ever a way between these two rails is set up by the switches then the alarm sounds. The circuit shows all the switches in the *starting* position i.e. all the missionaries and cannibals are on the near bank. Note that when any person goes over the river *all* switches changeover. The customary dotted lines showing the connections between coupled switches have been omitted for clarity. Thus, if M1 crosses the river, switches M1a, M1b, M1c, M1d, M1e, M1f, M1g and M1h all changeover.

You can work out the circuits for the alarm to sound. Here are three examples. Suppose all three cannibals stay on the start side and M1 goes over. Then the cannibals outnumber the missionaries on the start side and so the alarm sounds — through C2b, C3b, C1b, M2d, M2c and M1d which has changed over.

Similarly, if M2 went over alone then the alarm would sound through C2b, C3b, C1b, M3d, M1d, M3b and M2a which has changed over.

And if M3 went over alone the alarm sounds through C2b, C3b, C1b, M1c, M2c, M1d and M3b which has changed over.

You can check all the 'alarm should sound' configurations on each bank of the river by visualising an alarming situation — cannibals outnumbering missionaries, and then tracing through the switches to find a circuit. Similarly the 'alarm should not sound' circuits, or rather 'no' circuits can be checked in the same way.

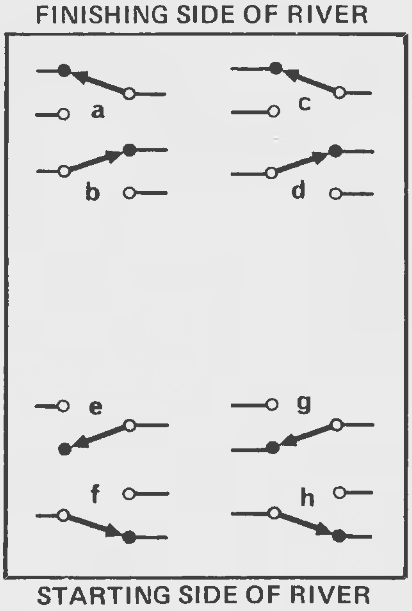


Fig. 3 Terminal layout on standard key switch with four changeover on each half. Contacts shown as being made in this diagram are with the lever in the central position.

PARTS LIST

Six standard phone type key switches type 4CL/4CL which means 4 changeover locking switches on each half of the switch.
The prototype used MLK lever switches code number MLK 10
One buzzer and battery holder — ex bicycle horn
One suitable box and panel
Hook up wire etc.

CANNIBALS and MISSIONARIES

situations on both banks and see that the alarm sounds when it should. Also check the no-alarm situations – i.e. when cannibals do not outnumber missionaries on either bank of the river.

Fault finding is not as daunting as it may appear at first. A logical working through the circuit diagram should help to pin point any problem.

HAVE A GO

Having built the puzzle – try to solve it. It's far from easy. If you haven't solved it inside a month or two – a solution is provided on page 90 of this book!

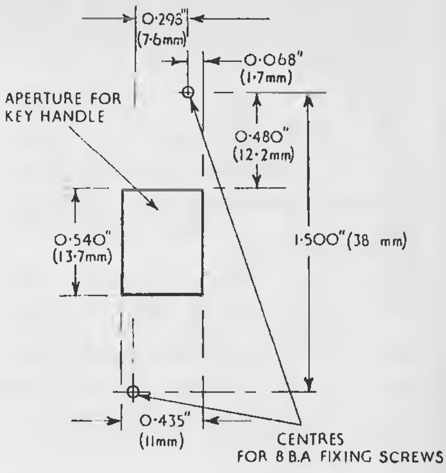


Fig. 4 Dimensions of aperture needed and hole positions for standard key switch.

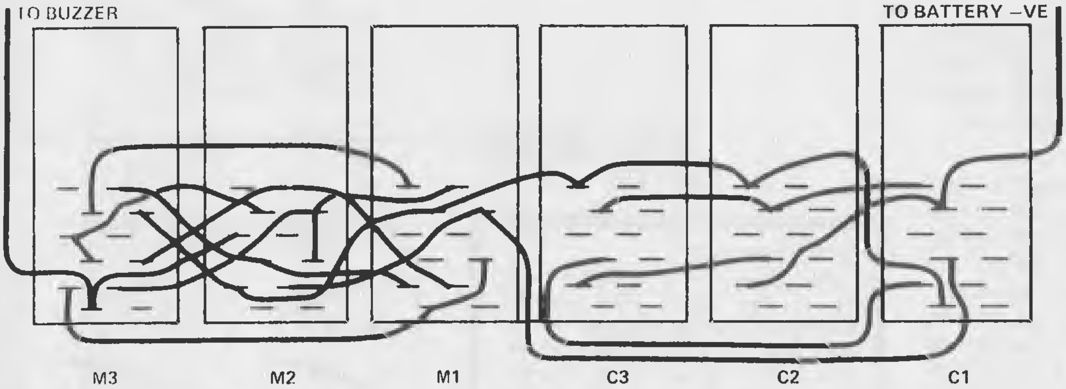


Fig. 5 Wiring on switches on the start side i.e. on switches 'e' to 'h' of each key switch.

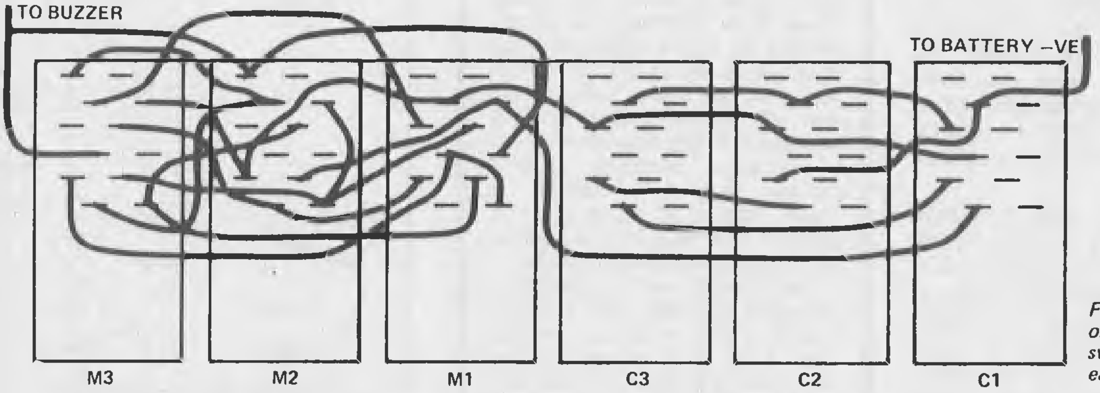


Fig. 6 Wiring on switches on finish side i.e. on switches 'a' to 'd' of each key switch

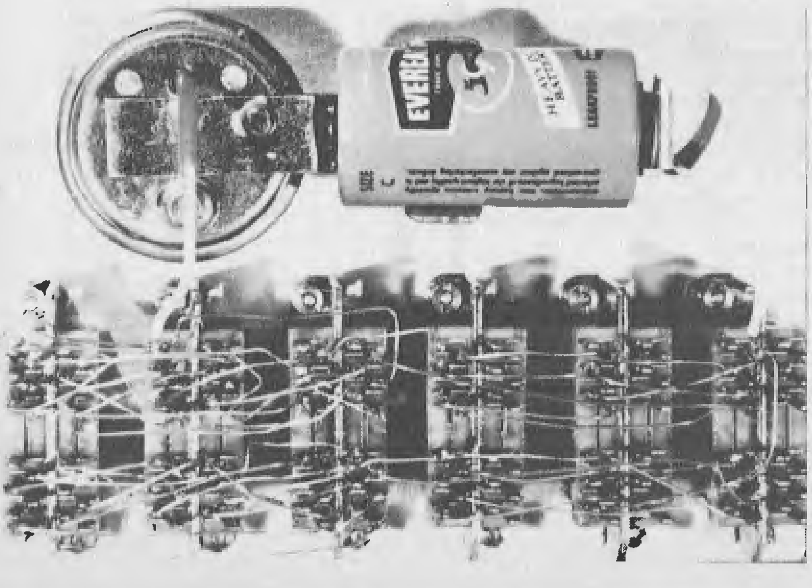


Fig. 7 Underside view of the panel.

PARTS LIST

Six standard phone type key switches type 4CL/4CL which means 4 change-over locking switches on each half of the switch.
The prototype used MLK lever switches code number MLK 10
One buzzer and battery holder — ex bicycle horn
One suitable box and panel
Hook up wire etc.

Project Building Guide

WHY DOESN'T IT WORK?

Don't call us — just read this!

OCCASIONALLY we and kitset suppliers receive phone calls (some abusive and some plaintive) from project builders who have been unable to get a project to work. Almost invariably when such complaints are investigated it is found that the problem is due to one of several common mistakes made by beginners.

The most common single cause of trouble is poor soldering. Good soldering technique is *absolutely essential*. A beginner would be amply rewarded by studying the "How to Solder" article on page 89. For example a digital clock kit built by one reader exhibited all kinds of queer faults but after reworking *all* the solder joints — the clock worked perfectly.

A further example involved one of our special IC offers. A young reader complained that both the ICs he received were faulty. We replaced these free of charge but were subsequently told that these too were faulty.

As only a tiny proportion of new ICs are faulty (<1% typically) the chances of a reader receiving two bad ones is remote — to receive four is improbable in the extreme.

On further investigation we found that very poor soldering had not only destroyed the ICs — it had ruined the pc board as well.

CONNECTIONS

In every constructional article constructors are warned to check orientation of components yet, in many cases where complaints are investigated ICs, transistors, diodes and capacitors are found to be inserted the wrong way round. Double check orientation (or even triple check) before soldering in components. Give the whole board another check before switching on the power.

Note particularly that different brands of transistor having the same part number (eg BC548, BC558 series) may have *different* pin connections. Other transistors that are electrically similar to each other may have different pin connections again. (The correct pin connections are generally shown in ETI projects — if in doubt, refer to manufacturers' data sheets).

On several occasions we have seen components located on the copper side of PC boards rather than the non-copper side! This requires considerable mental dexterity to reverse correctly the component lead configurations given in component overlays. It *can* be done but it invariably leads to foul-ups!

Power transistors must be fitted to the correct specified heat sinks. Where specified they *must* be correctly insulated from the heatsink.

Fit components snug against the board and keep wiring as short as possible. Untidy assembly inevitably leads to wiring errors.

To return to soldering again, use only enough solder to make a good joint. Using too much solder can result in bridges between tracks or IC pins that are sometimes difficult to detect visually.

Where a setting up procedure is given make sure that the procedure is followed *exactly*. For example power transistors may be destroyed if the bias control is set at the wrong end when a power amplifier is first switched on.

SUBSTITUTION

Don't substitute components for those specified unless you know *exactly* what you are doing. Time and time again we waste hours trying to advise a reader how to fix a project that won't work — only to find that despite denials — a completely unsuitable component has been substituted for that specified. In one example a reader completely 'redesigned' our allegedly faulty power supply because he didn't appreciate that a transformer has a much higher output voltage off-load to on-load — then he wondered why his resultant supply produced too low a voltage to drive the rest of the project.

There are one or two minor exceptions to the above — for example some (generally overseas) projects specify 50 k or 500 k potentiometers. However most manufacturers now produce potentiometers in preferred ratings only — i.e. 4 k7, 47 k, 470 k etc. These may be substituted directly.

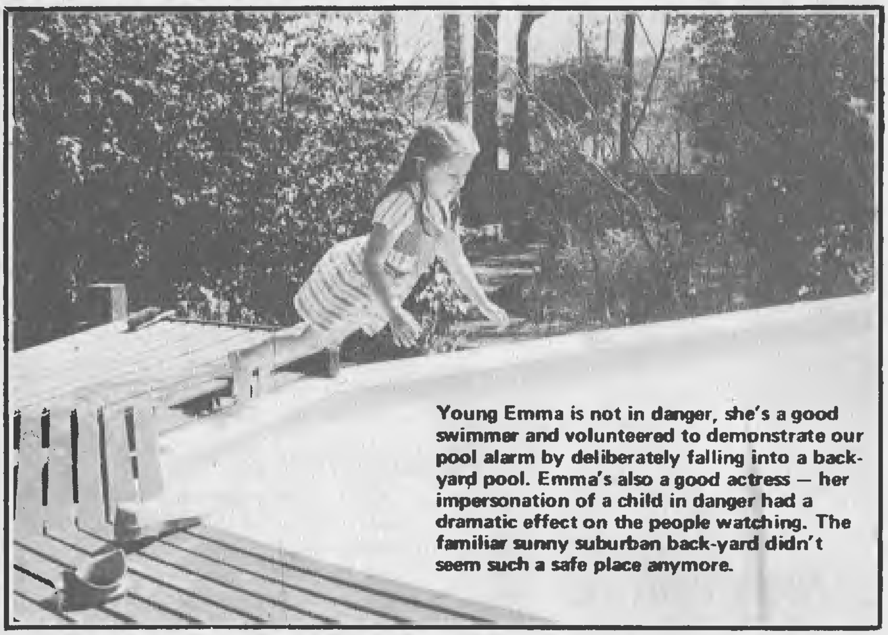
Resistors are made in various tolerances — 1%, 5%, 10% and 20% for example. Most projects specify 10% or 20% resistors — in other words the value is not critical within ± 10% or 20%. Therefore it is often perfectly satisfactory to replace a nominal 470 k resistor with say a 430 k resistor if the latter's value is reasonably accurately known, for the 430 k is well within the 10% tolerance of the nominal value.

Even greater liberties may often be taken with electrolytic capacitors where tolerances of 50% (or even 100%) of capacity are quite normal.

Generally though it is best to assume that the circuit's designer knows more about the project than you do. So stick to the components specified! ●

SWIMMING POOL ALARM

Safeguard children with this easy-to-build alarm



Young Emma is not in danger, she's a good swimmer and volunteered to demonstrate our pool alarm by deliberately falling into a back-yard pool. Emma's also a good actress — her impersonation of a child in danger had a dramatic effect on the people watching. The familiar sunny suburban back-yard didn't seem such a safe place anymore.

EVERY YEAR fifteen to twenty children are drowned in home swimming pools. And that's in NSW alone.

In some States it is now compulsory to erect a high fence — with a lockable gate — around the pool. But even three and four year olds can and do climb fences, and gates are only too easily left unlocked. Even if fenced in, some form of reliable warning device is essential.

Some time ago Electronics Today ran a design contest inviting readers to submit their solution to this increasing problem.

Three main types of alarm were submitted.

1/ Floating devices that sense water ripples.

2/ Hydrophonic devices that detect the sound component of the splash.

3/ Light beams and sensors guarding the perimeter of the pool.

The most completely effective entry was a hydrophonic device that detected the sound of the splash. This unit had an inbuilt spectrum analyser to eliminate false alarms. Although ingenious and effective the device ultimately proved too complex to present as a constructional project.

A light beam and photocell barrier can also be very effective but it is difficult (in practice) to ensure the alignment of the system right around the pool. One entrant suggested that three parallel beams be used. The first two were spaced close together — the third was about one and a half metres from the ground. The outputs from the photocells were connected to a logic system set up so that no alarm would sound if all three beams were broken — or only one was broken. Thus birds and adults could pass through the beams at any time without causing alarm. A toddler however would break the lower *two* beams thus sounding the alarm.

The simplest and potentially most reliable systems used some form of differential float to sense water surface ripples. The basic principle of these devices is that only ripples *shorter* than the spacing between the floats will cause one float to move with respect to the other. Long wave ripples (such as those caused by wind blowing across the pool) will move the assembly as a whole.

One design of this type was submitted by Mr. G. Goodwin. This system has been further developed and extensively tested since the contest and is presented here in a form suitable for building by anyone who can use simple tools.

The sensing part of the alarm consists of an upright central tube which is supported in the water by three small floats. The central pillar carries a further small float which is free to move up and down the pillar.

This moving float has a pair of small magnets sealed within it, and a magnetically operated reed switch is housed within the central pillar — near the top.

The whole assembly floats in the water, with the central float normally resting some short distance below the point at which the reed switch is actuated.

In the event of a short sharp wave, such as that caused by a toddler or animal falling or slipping into the pool, the central float will be caused to momentarily rise with the wave thus actuating the reed switch.

Waves of longer pitch will move the assembly as a whole — there will be no differential movement.

Once the switch is triggered the alarm locks on and the warning mechanism will continue to sound even though the disturbing ripples have ceased. The alarm can only be turned off by pressing a reset button.

The unit's sensitivity is adjusted by moving the main float assembly up or down the central pillar. It is quite simple to set the unit so that it will respond only to the kind of waves produced by a child falling into the pool — but to ignore wind produced ripples.

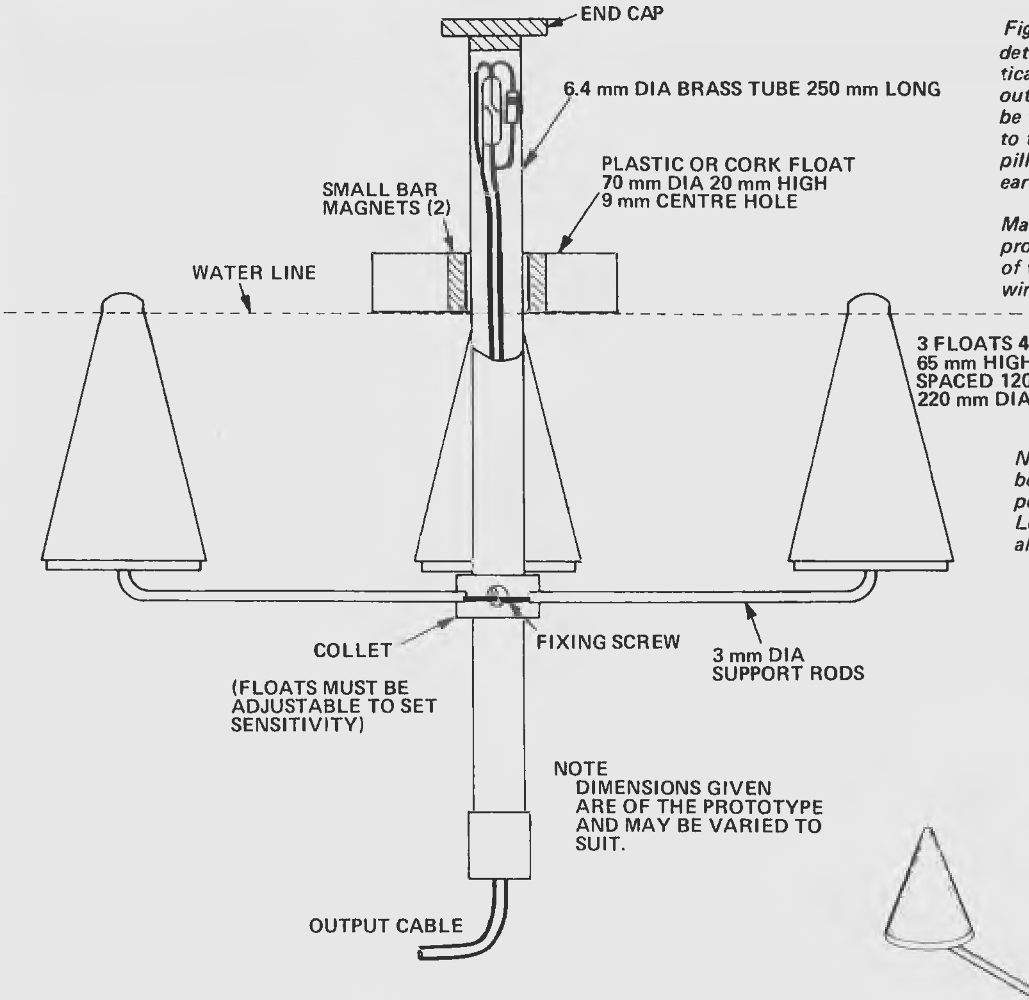
As mentioned above it is necessary to have some type of circuit associated with the sensor to ensure that the unit, once triggered, will continue to sound an alarm even though the initial ripples die away.

The simplest way to do this is to use a relay with two pairs of contacts. One pair is used to connect power to the alarm bell — the second pair is used to cause the relay to 'self-latch'. This method is very reliable and has the advantage that almost any type of alarm bell can be used.

Figure 2 shows how the relay is connected to the float assembly. Twin bellwire or plastic coated lighting flex will be adequate for the wiring between the two parts of the unit. House the relay assembly and battery indoors so that it is dry and accessible.

We have not included an on/off switch in the circuit — it's too easy to forget to turn the unit back on. It's less convenient, but safer, to lift the sensor unit from the pool and to place it somewhere totally obvious when the pool is in use.

Connections may differ from relay to relay but if in doubt anyone with basic

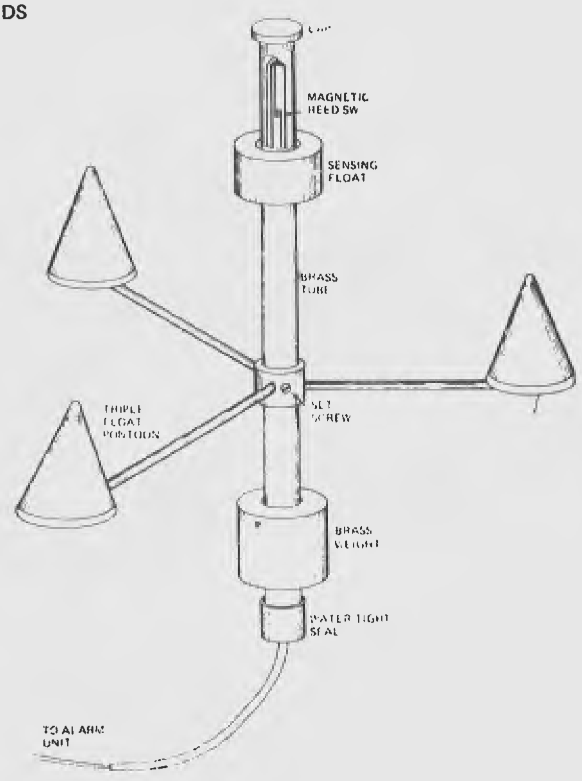


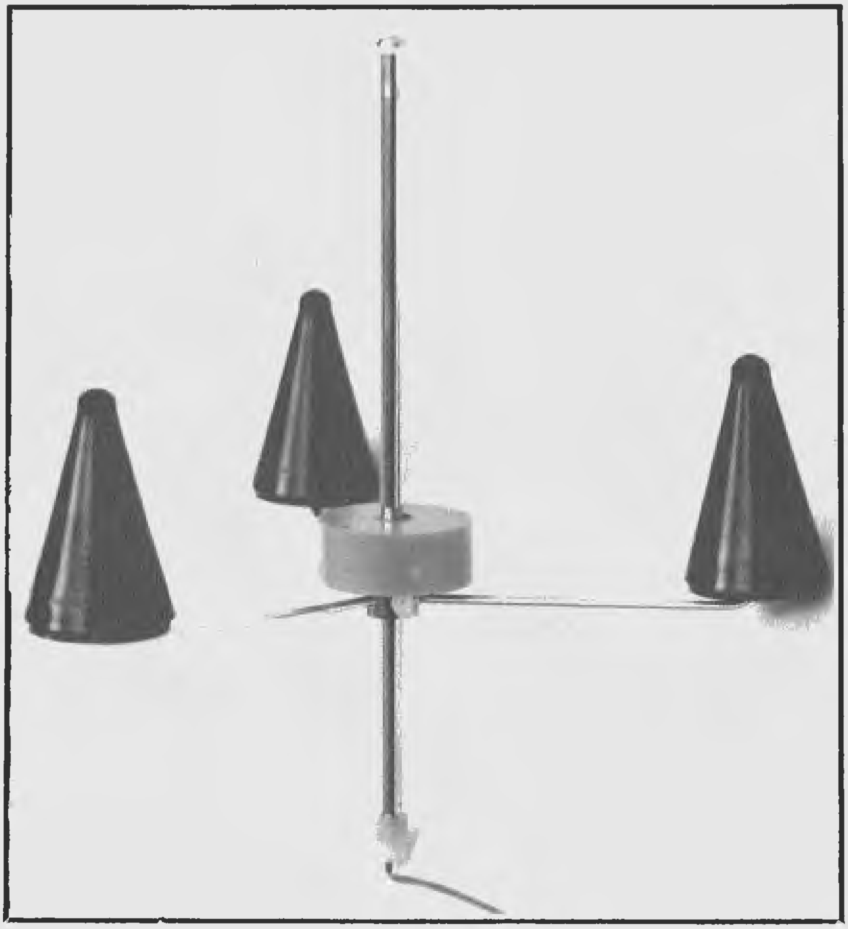
NOTE
DIMENSIONS GIVEN
ARE OF THE PROTOTYPE
AND MAY BE VARIED TO
SUIT.

Fig. 1. This drawing shows the basic details, the dimensions are not critical but should not be varied without prior experimentation. It may be found necessary to add a weight to the lower part of the central pillar as shown in our sketch of an earlier prototype (right).

Materials chosen must be corrosion-proof and sealed against the ingress of water. Note how the diode is wired across the reed switch.

NOTE: The complete unit must be moored near the centre of the pool by a suitable cord and weight. Leave enough slack in the cord to allow for water level variations.

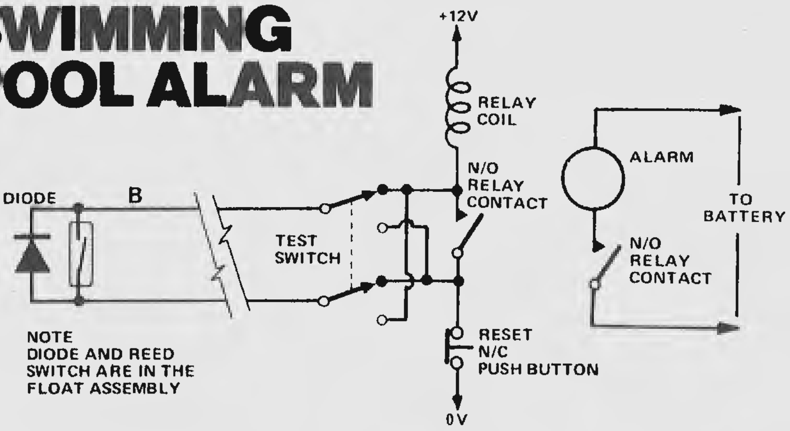




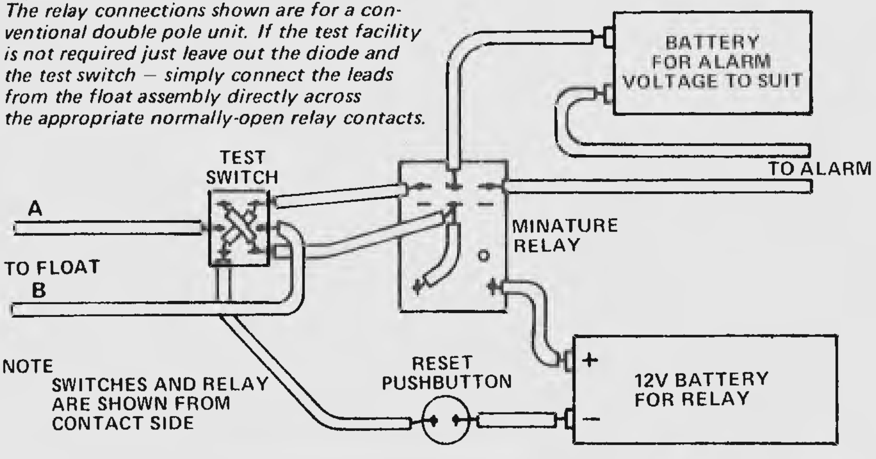
PARTS LIST

One double pole change over switch-any type
One push-to-break pushbutton switch
One double pole single throw (or change over) relay suitable for 12 volt operation.
One diode — any signal diode
One ORD 234B reed switch (or similar)
Two FM 454 magnets
Materials for float as obtainable

SWIMMING POOL ALARM



Figures 2 and 3 show how the unit is wired. The relay connections shown are for a conventional double pole unit. If the test facility is not required just leave out the diode and the test switch – simply connect the leads from the float assembly directly across the appropriate normally-open relay contacts.



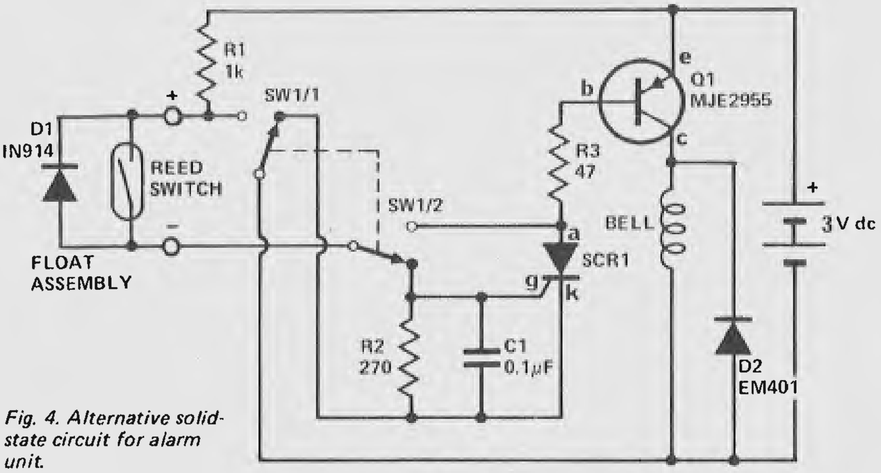


Fig. 4. Alternative solid-state circuit for alarm unit.

electrical knowledge will be able to tell you which connection is which.

The float assembly should conform generally to the drawing shown in Fig. 1. The central pillar may be made of brass or plastic tubing – but not steel. The floats were originally moulded specifically for the project out of polythene. They can however just as readily be made from light wood (well varnished to prevent water absorption) or cork. Plastic bottles or jars can also be adapted.

The reed switch and diode must be very securely fixed within the central pillar – which must then be securely sealed to prevent the ingress of water. An excellent way to do this is to fill the entire column with windscreen sealant or similar plastic goo.

The completed float assembly should be moored in the centre of the pool by a cable and weight resting in the bottom of the pool. Allow sufficient slack in the cable to allow for variations in the depth of water in the pool.

Figure 3 shows an alternative electronic switching and latching circuit. This is a form of construction suggested by Mr. Goodwin. It has been chosen so that the whole unit will fit into an existing Friedland door bell – which is powered by an inbuilt three volt battery.

This form of construction is certainly neat but in our opinion a simple double pole relay does the job equally well and with greater potential reliability. A 12 volt bell may also be used with the simple relay system and this will be heard over far greater distances than a simple door bell – no matter how adequate the latter may be for its originally intended purpose.

A diode is wired across the reed switch in both circuits. The purpose of this diode is to enable the entire wiring circuit to be checked for integrity by pressing a 'test' button. This facility does not of course check the reed switch itself nor the actual floating assembly. In our opinion the whole unit should be checked daily by throwing a suitable mass into the pool. (A water filled football or one gallon can simulate the mass of a small child very adequately). ●

REED SWITCH AND MAGNETS

A reed switch consists of two springy metal strips inset into a glass tube filled with inert gas.

The strips are caused to close together and make contact by a magnetic field.

A suitable reed switch for this project is the type ORD 234B from Plessey Ducon. Suitable magnets are type FM 454 also from Plessey. Two magnets are required for each assembly.

Plessey have kindly agreed to supply our readers with a set of one reed switch and two magnets for $1.50 per set including packing and postage.

The components may also be stocked by kit set and component suppliers.

Copy this coupon on plain paper if you don't wish to cut up your copy of this issue.

To:

**Plessey Ducon Ltd.
Professional Components Division
Christina Ave.
Villawood NSW**

Please forward one reed switch type ORD 234B and two magnets type FM 454, I enclose cheque/postal order to the value of $1.50 to cover cost of same.

Name: . . . .

Address: . . . .

. . . . .

. . . . Postcode . . . .

NOTE

This unit has been extensively tested and has proved to be both effective and reliable.

However like any mechanical or electrical device, failures can occur. It is therefore imperative to follow normal swimming pool safety precautions even though this alarm is in use.

PROJECT 232

COURTESY LIGHT EXTENDER

Car interior light stays on briefly after the door is closed

ALL MODERN CARS are fitted with door-switch operated courtesy lights. Useful devices, but not *quite* as useful as they might be because they are so arranged that the light is extinguished as soon as you close the door — just when you need light to find the ignition switch, do up your seat belt etc. How much better if the internal light stayed on for a few seconds *after* the door is closed.

This little project does just that. It provides a four-second delay (approx) after which the interior light slowly dims — being finally extinguished after 10 or 12 seconds.

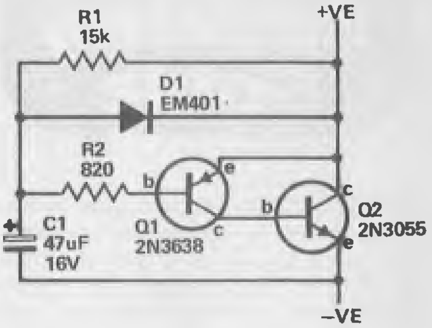
The unit is very simple to construct and once tested and properly insulated it may be wired across one of the car door switches. In operation, after a short delay the lights will gradually dim until they are completely extinguished. There is no battery drain in the off-state as the unit only operates during the delay period after the door is closed.

CONSTRUCTION

In our prototype, as shown in the photograph, all the components are assembled directly onto the 2N3055 transistor. This only requires two "mid-air" joints to be made.

After checking that the unit works correctly the assembly may be placed in a small plastic pill box which is then filled with epoxy. Alternatively merely wrapping the unit in insulation tape will be sufficient.

Due to the fact that the 2N3055 only conducts for a few seconds every so often, a heatsink is not required for cars fitted with a single lamp courtesy light. If your car has *more* than the usual amount of interior lighting operate the unit a number of times in fairly quick succession. Then, if the 2N3055 gets too hot to touch, use a small piece of aluminium as a heatsink. This need should however be rare. ●



PARTS LIST
ETI 232

R1	resistor	15 k ½ watt 5%
R2	"	820 ½ watt 5%
C1	capacitor	47μF 16 volt electrolytic
D1	diode	EM401 or similar
Q1	transistor	2N3638 or similar
Q2	"	2N3055

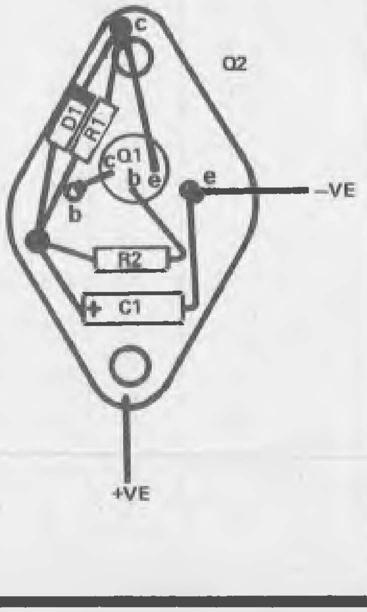
HOW IT WORKS

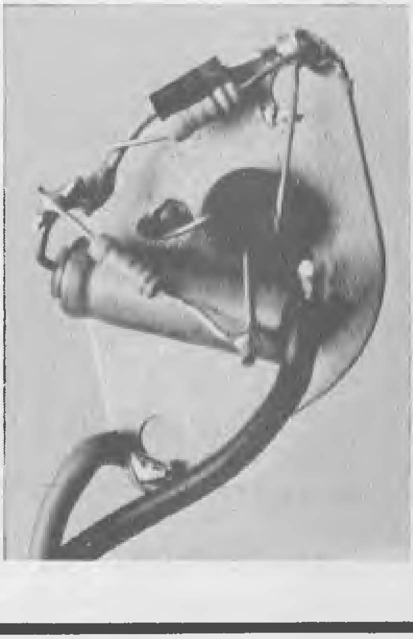
Most car door switches are simply single-pole switches, with one side earthed. When the door is opened the switch earths the other line thus completing the light circuit.

In a car where the negative terminal of the battery is connected to the chassis the negative wire of the unit (emitter of Q2) is connected to chassis and the positive wire (case of 2N3055) is connected to the wire going to the switch. In a car having a positive earth system this connection sequence is reversed.

When the switch closes (door open) C1 is discharged via D1 to zero volts and when the switch opens C1 charges up via R1 and R2. Transistors Q1 and Q2 are connected as an emitter follower (Q2 just buffers Q1) therefore the voltage across Q2 increases slowly as C1 charges. Hence Q2 acts like a low resistance in parallel with the switch – keeping the lights on.

The value of C1 is chosen such that a useful light level is obtained for about four seconds, thereafter the light decreases until in about 10 seconds it is out completely With different transistor gains and with variation in current drain due to a particular type of car the timing may vary, but may be simply adjusted by selecting C1.





RESISTOR COLOUR CODE

(standard carbon series)

Project Building Guide

RESISTORS of 1% tolerance sometimes have a five band code. The same colour codes are used but the first three bands represent the first three digits and the fourth band is the multiplier. With these resistors only a few of the standard values coincide with those of the four band coded resistors. For example 220 k is standard in four band code but 221 k is standard in five band code.

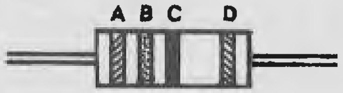
To read the colour code, hold resistor with code ring nearest to end at left hand side.

Colour	1st ring; 1st figure	2nd ring 2nd figure	3rd ring multiplier	4th ring tolerance
black	–	0	1	–
brown	1	1	10	±1%
red	2	2	10^2	±2%
orange	3	3	10^3	–
yellow	4	4	10^4	–
green	5	5	10^5	–
blue	6	6	10^6	–
violet	7	7	10^7	–
grey	8	8	10^8	–
white	9	9	10^9	–
silver	–	–	10^{-2}	±10%
gold	–	–	10^{-1}	±5%

No fourth colour indicates ±20% tolerance

Grade 1 ('high-stability') resistors are distinguished by a salmon-pink fifth ring or body colour.

Example: Resistor coded as A – grey, B–red, C–orange, D–gold indicates a value of 82 kilohms ±5%.



STANDARD VALUES

This table shows the preferred series of values in a decade.

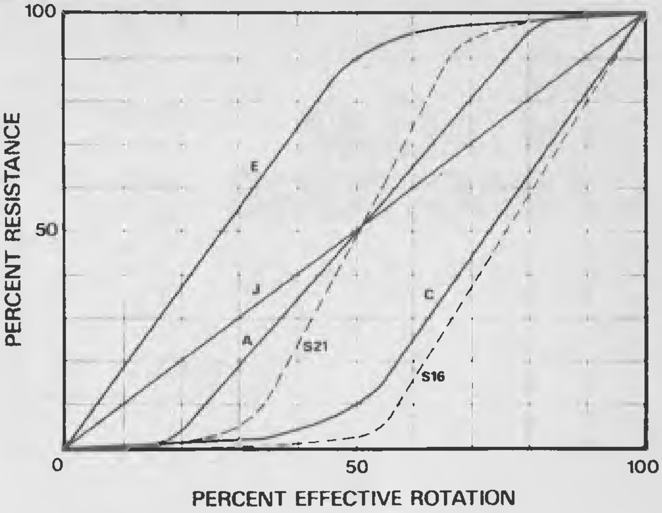
RESISTORS and capacitors are generally made with the values and tolerances shown. For example 20% tolerance resistors are usually made in values of 10, 15, 22, 33, 47 and 68 – whether ohms, kilohms or megohms. Thus a (nominally) 47 k, 20% resistor may have an actual value somewhere between 37.6 k and 56.4 k. A (nominally) 33 k, 20% resistor may in fact be as low as 26.4 k or as high as 39.6 k.

Closer tolerance resistors such as 10% or 5% are not necessarily better resistors — merely that the manufacturers have weeded out products falling outside the tolerance limits.

VALUES IN A DECADE

20%	10%	5 or 2%	1%							
10	10	10	100	133	178	237	316	422	562	750
		11								
	12	12	102	137	182	243	324	432	576	768
		13								
15	15	15	105	140	187	249	332	442	590	787
		16								
	18	18	107	143	191	255	340	453	604	806
		20								
22	22	22	110	147	196	261	348	464	619	825
		24								
	27	27	113	150	200	267	357	475	634	845
		30								
33	33	33	115	154	205	274	365	487	649	866
		36								
	39	39	118	158	215	287	383	511	681	909
		51								
	56	56	124	165	221	294	392	523	698	931
		62								
68	68	68	127	169	226	301	402	536	715	953
		75								
	82	82	130	174	232	309	412	549	732	976
		91								

POTENTIOMETERS



Resistance/rotation curves for commonly used potentiometers.

POTENTIOMETERS are made in many different forms for a vast number of applications. Factors which affect design are, for example, wattage and resistance range, whether the control is to be continually or intermittently adjustable, the 'law' of resistance and the variety of mechanical arrangements required.

POWER RATING

The maximum power which may be dissipated is specified for the condition where a voltage is applied across the end terminals continuously. However under certain conditions power dissipations much lower than this can cause damage. This is because the resistive element also has a maximum *current* limitation. Thus a potentiometer set to its lowest resistance could be damaged if excessive current were drawn via the slider terminal.

LAW

Potentiometers are constructed with various relationships of resistance versus rotation. Those most commonly used in Australia are:—

A linear
J linear
C logarithmic
E anti-log

The type of relationship (law) used is indicated by stamping the appropriate letter symbol on the body of the potentiometer, eg 10 kC is a 10 k ohm logarithmic potentiometer.

LOG OR LINEAR?

Most human perception is of a logarithmic nature (eg hearing, where a doubling of power is just perceivable). Hence logarithmic potentiometers are frequently used for volume controls as the logarithmic change in resistance (versus rotation) is 'heard' as a linear level-change versus rotation. Logarithmic — potentiometers are not accurate, so, where an accurate mid-point setting is required, (for example in tone controls) they are seldom used except in cheaper equipment.

TAPPED POTENTIOMETERS

Tapped potentiometers are generally used where some form of frequency compensation versus rotation is required. They are often used in 'loudness' controls, (bass and treble frequencies boosted at low volume levels). Tapped potentiometers are usually specially made for a specific application. Because of this they are not generally available from hobbyist supply sources.

BALANCE CONTROLS

Balance controls are built with two separate elements connected such that each alters resistance in the opposite sense. Such controls are used where it is required accurately to balance the gain of a pair of amplifiers. Such accurate balance is not required in domestic stereo amplifiers and hence in this application a single gang potentiometer is generally used.

GANGING

Potentiometers may be obtained with two or three resistance elements driven by a common shaft. These are commonly used for volume and tone controls for stereo amplifiers.

SERIES AND PARALLEL CONNECTIONS

Resistors in series

$$R_{total} = R1 + R2 + R3 + \ldots$$

Resistors in parallel

$$R_{total} = \frac{R1 \times R2}{R1 + R2}$$

Capacitors in series

$$\frac{1}{C_{total}} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \cdots$$

Capacitors in parallel

$$C_{total} = C1 + C2 + C3 + \ldots..$$

TAG TANTALUM CAPACITORS

Because of their small physical size tag tantalum capacitors are ideal for miniature electronic work. They are more expensive than standard electrolytics though.

WORKING VOLTS	CAPACITANCE RANGE AVAILABLE
3	10 – 100 µF
6.3	6.8 – 47 µF
10	4.7 – 33 µF
16	2.2 – 22 µF
25	3.3 – 10 µF
35	0.1 – 6.8 µF

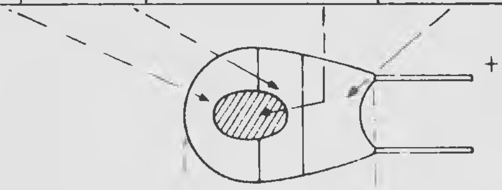
Tolerance ± 20%

▶

PROJECT BUILDING GUIDE

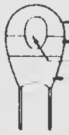
TAG TANTALUM CAPACITORS

CAPACITANCE IN µF				D.C. WORKING VOLTAGE	
COLOUR	1st RING	2nd RING	POLARITY and MULTIPLIER	COLOUR	VOLTS
Black	–	0	x 1	White	3
Brown	1	1	x 10	Yellow	6.3
Red	2	2		Black	10
Orange	3	3		Green	16
Yellow	4	4		Blue	20
Green	5	5		Grey	25
Blue	6	6		Pink	35
Violet	7	7			
Grey	8	8	x 0.01		
White	9	9	x 0.1		



N.B. – The above sketch shows the position of the coloured spot which serves both as multiplier and anode indicator.

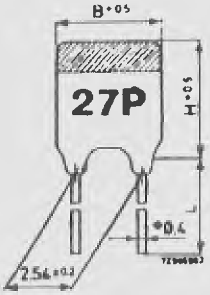
EXAMPLE
6.8µF/25 volts



BLUE 6
GREY 8
WHITE 0 1
GREY
} 6.8µF
25 Volts

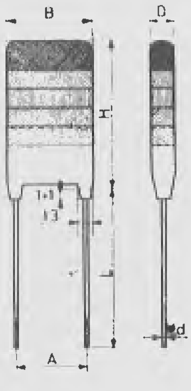
CERAMIC CAPACITORS

capacitance (pF)	marking	capacitance (pF)	marking	capacitance (pF)	marking
0.68	**p68**	5.6	**5p6**	47	**47p**
0.82	**p82**	6.8	**6p8**	56	**56p**
1.0	**1p0**	8.2	**8p2**	68	**68p**
1.2	**1p2**	10	**10p**	82	**82p**
1.5	**1p5**	12	**12p**	100	**n10**
1.8	**1p8**	15	**15p**	120	**n10**
2.2	**2p2**	18	**18p**	150	**n15**
2.7	**2p7**	22	**22p**	180	**n18**
3.3	**303**	27	**27p**	220	**n22**
3.9	**3p9**	33	**33p**	270	**n27**
4.7	**4p7**	39	**39p**		



POLY-CARBONATE CAPACITORS

colour	1st figure of cap. value	2nd figure of cap. value	multiplying factor	capacitance tolerance	working voltage
black	-	0	1	±20%	
brown	1	1	10		
red	2	2	10^2		250 V
orange	3	3	10^3		
yellow	4	4	10^4		400 V
green	5	5	10^5		
blue	6	6			630 V
violet	7	7			
grey	8	8			
white	9	9		±10%	

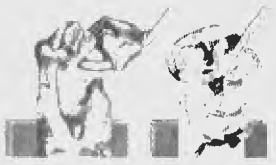


HOW TO SOLDER

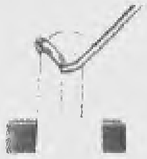
Good soldering is most important — many of the problems that beginners have with their first projects are due to poor joints. The following hints will aid you to become adept at soldering.

1. Purchase a good quality iron with a wattage rating between 15 and 25 watts.
2. Use only resin-cored solder (60/40 tin-lead content). Do not use acid flux.
3. A new, or worn, iron will need tinning. To do this let the iron get quite hot and file the tip smooth to expose fresh clean copper. Quickly, before the copper has time to discolour, apply resin — cored solder — it should flow all over the tip forming a shiny coating.
4. Keep your soldering iron clean. Wipe it frequently with a damp cloth or sponge.
5. Make sure the connection to be soldered is clean. Wax, frayed insulation, and other foreign substances will result in inferior joints.
6. With older components, or copper wire, it will be necessary to clean and tin the individual components before soldering them together (see 3 above).
7. Attach the wires to be soldered. Do not make more than a half turn in a lead to be soldered — twisting makes subsequent removal difficult.
8. Heat the connection with the iron and apply the solder to the connection. Do not melt solder on the iron and carry it to the joint.
9. Keep the iron on the joint until the solder just commences to flow on the connection. Too little heat results in a high-resistance joint (known as a dry joint) too much causes component damage and evaporates the tin component again causing a poor joint. This step requires practice.
10. Let the solder harden before moving the connection. Then check for a smooth bright joint. A joint that has been moved will have a crystalline appearance, may have a high resistance and will fracture easily.

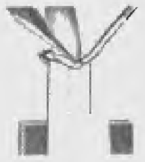
Good soldering is a matter of practice. If you follow the above hints, it will be only a matter of time till you are making professional joints.



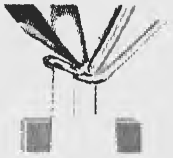
Poor connections look crystalline and grainy, or the solder tends to blob.



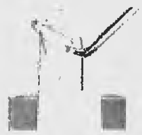
Attach the wire.



Heat both the wire and the connection point.



Apply solder to both the tip and the connection.



Let the connection harden before moving the wire. Then check for a smooth, bright joint.

BUYING COMPONENTS

AS far as reasonably possible, all ETI projects are designed around components readily available 'off the shelf' from specialist component and kit set suppliers.

Many enthusiasts will have accumulated substantial stocks of components over the years and because of this may need to buy only a few odds and ends to build most projects. Beginners on the other hand will generally find it much simpler to buy a complete kit of parts.

The companies listed below stock components and/or kits sets for most (but not necessarily all) ETI projects.

BUYERS' GUIDE

ACT
Electronic Components, 3 Pirie Street, Fyshwick, 2609

NSW
Classic Radio Service, 245 Parramatta Road, Haberfield, 2045.
Dick Smith Wholesale Pty. Ltd. 160-162 Pacific Highway, Gore Hill. 2065.
Edge Electrix, 34A Burwood Road, Burwood, 2134.
Electronic Mailbox, P.O. Box 355, Hornsby, 2077.

George Brown Pty Ltd, 174 Parramatta Road, Camperdown, 2050
Hi-Tec Electronics, 265 Princes Highway, Corrimal, 2518.
Instrol Electronics, 91a York Street, Sydney, 2000
John Carr Pty Ltd., 405b Sussex Street, Sydney, 2000

M.S. Components, 95 Regent Street, Redfern, 2016
National Radio Supplies, 332 Parramatta Road, Stanmore, 2048
Oliver Electronics, 188-192 Pacific Highway, St. Leonards, 2065.
Pre-Pak Electronics, 718 Parramatta Road, Croydon, 2132.
Radio Despatch Service, 869 George Street, Sydney, 2000
Tandy Int. Electronics Pty Ltd., 280-316 Victoria Road, Rydalmere, 2116

QLD.
Dunmark Electronics, P.O. Box 702, Booval, 4304

TAS
Homecrafts (Tas.) Pty Ltd., 199 Collins Street, Hobart, 7000

VIC.
E. D. & E. (Sales) Pty Ltd., 232 Flinders Lane, Melbourne, 3000
Ham Radio Supplies, 104 Highett Street, Richmond, 3121
Hobipak, P.O. Box 224, Carlton South, 3053
J. H. MacGrath & Co. Pty. Ltd., 208 Little Lonsdale Street, Melbourne 3000
Lanthur Electronics, 69 Buchanan Avenue, North Balwyn, 3104
Radio Parts Group, 562 Spencer Street, West Melbourne, 3003
Royston Electronics Pty Ltd., 22 Firth Street, Doncaster, 3108
S.T.A. Electronics, 392 Centre Road, Bentleigh, 3204
Wayne Communications Electronics, 757 Glenferrie Road, Hawthorn, 3122

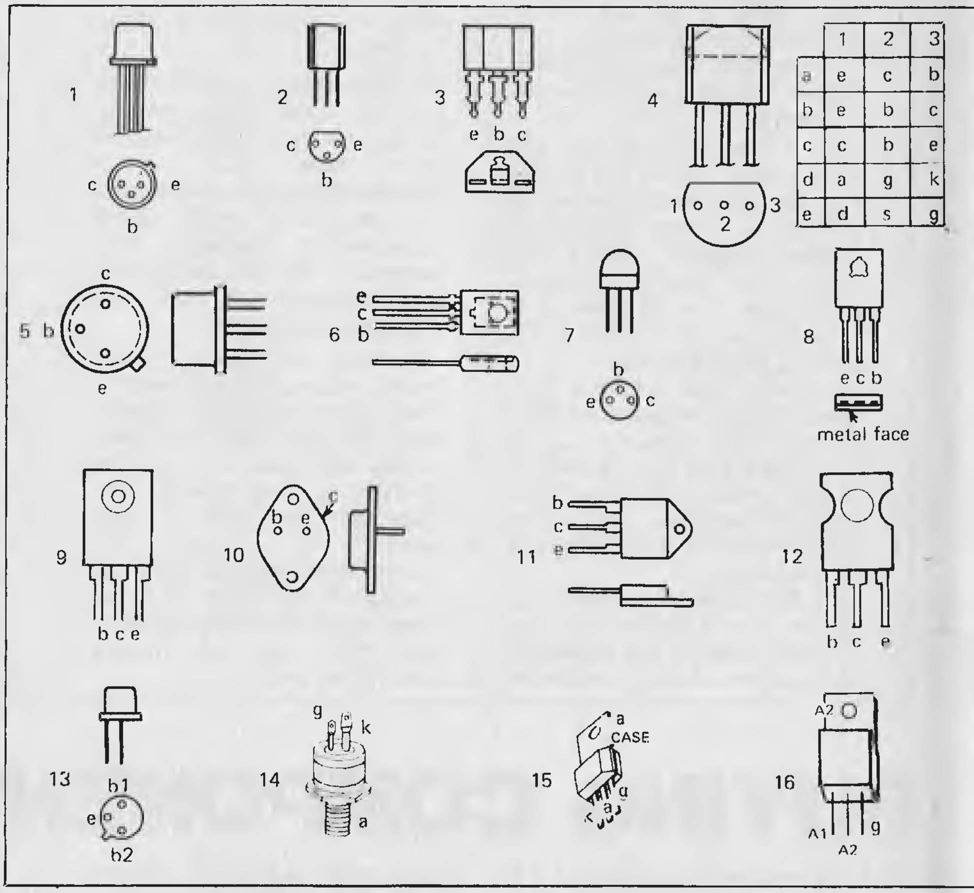
NZ
Kitparts Ltd, Christchurch, New Zealand

USA
Babylon Electronics, P.O. Box J, Carmichael, California, 95608, USA.
International Electronics Unlimited, P.O. Box 1708, Monterey, California, 93940, USA.

** Head Office addresses only are shown. Many suppliers have other premises inside and outside the home state. To find if there is a branch in your area consult the advertisements in Electronics Today International or the telephone directory.*

TRANSISTOR CONNECTIONS

TRANSISTORS	CONNECTIONS
BC107	1
BC108	1
BC109	1
BC147	3
BC148	3
BC149	3
BC157	3
BC158	3
BC159	3
BC177	1
BC178	1
BC179	1
BC182K	4c
BC182L	4a
BC237	4c
BC238	4c
BC239	4c
BC307	4c
BC308	4c
BC309	4c
BC547	2
BC548	2
BC549	2
BC557	2
BC558	2
BC559	2
BD139	6
BD140	6
C30	14
C106	15
MJ802	10
MJ2955	10
MJ4502	10
MJE340	8
MJE340K	9
MJE2371	9
MJE2521	9
MJE2955	8 (K Suffix-9)
MJE3055	8 (K Suffix-9)
PN3638	4b
PN3643	4b
PN3644	4b
SC141	16
SC146	16
SC151	
TIP29	12
TIP30	12
TIP31	12
TIP32	12
TIP33	11
TIP34	11
TIP35	11
TIP36	11
TIP41	12
TIP42	12
TIP2955	11
TIP3055	11
TT800	5
TT801	5
2N2160	
2N2646	13
2N2647	13
2N3055	10
2N3638	7
2N3638A	7
2N3643	7
2N3644	7
2N5457 (MPF103)	4e
2N5458 (MPF104)	4e
2N5459 (MPF105)	4e
2N5484	4e
2N5485 (MPF106)	4e
2N5486	4e
2N5631	10
2N6027 (D13T1)	4d
2N6031	10



	1	2	3
a	e	c	b
b	e	b	c
c	c	b	e
d	a	g	k
e	d	s	g

Note – *Case 4 is used for various transistor configurations and the different connections are indicated in the table on the right of the case. For example, if connections 4c are indicated in the transistor list consult row c (far left on chart). The connections corresponding to pins 1, 2 and 3 are as follows, pin 1 is collector (c), pin 2 is base (b) and pin 3 is emitter (e).*

SOLUTION

CANNIBALS AND MISSIONARIES

For those who made the project and think it can't be solved – and for those still struggling with the problem on bits of paper – here's a solution:

M means any missionary. C means either of the non-rowing cannibals. C2 means the cannibal who can row.

1. C and C2 go over.
2. C2 comes back.
3. C and C2 go over.
4. C2 comes back.
5. M and M go over.
6. M and C come back.
7. M and C2 go over.
8. M and C come back.
9. M and M go over.
10. C2 comes back.
11. C and C2 go over.
12. C2 comes back.
13. C and C2 go over.

PRE·PAK electronics

SYDNEY: 718 Parramatta Road, CROYDON, N.S.W. 2132. P.O. Box 43, CROYDON, 2132. Phone: 797-6144.

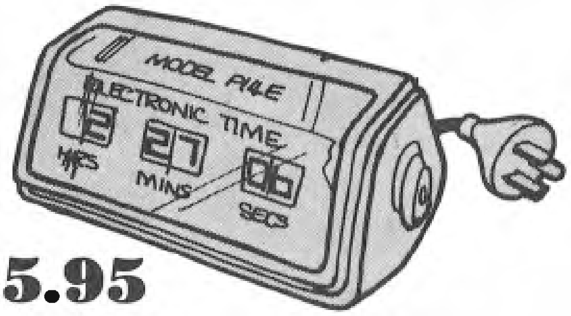
SYDNEY (CITY): 432 Kent Street, Sydney. Phone: 29-7426.

NEWCASTLE: Shops 3-6 West End Arcade, 810 Hunter Street., WEST NEWCASTLE, 2300. Phone: 69-2103.

"SPACE-AGE"

6 DIGIT CLOCK KIT

—COMPLETE WITH MODERN STYLE CASE



$35.95

"Space-Age" techniques permit the simple construction of a modern electronic clock in an attractive, compact case — AT VERY LOW COST.
Six large, bright green numerals indicate highly accurate time in 12 or 24 hour format. The kit includes P.C. board, IC and socket, transformer, case, etc. — AN IDEAL BEGINNERS PROJECT. $35.95. P&P $2.

6 DIGIT CALENDAR CLOCK KIT WITH ALARM

Similar in appearance to the one above, this de-luxe version indicates AM or PM as well as the date, which automatically appears (briefly) approximately every 10 seconds and features a built-in electronic audible alarm with "snooze" facility — i.e. the alarm will operate every 10 minutes until switched off. The kit is complete, as above, for only $47.95. P&P $2.

$47.95

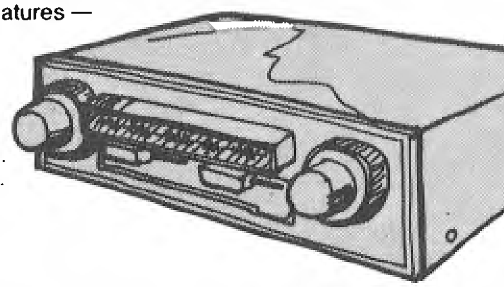
AM RADIO/STEREO CAR CASSETTE

HUGE PRICE REDUCTION!
Popular Expo model TC-601,
Suggested retail — $89.90.
Our price was — $84.90.
NOW ONLY — $69.00. P&P $2.50.

Flush mounting chrome or black vinyl speakers or rear shelf speakers available at $10.50 extra (pair). P&P $1.50. Lock-down aerial $3.50. P&P $1. Features —

- 5 watts/ch power rating.
- Fast forward lever.
- In dash or under dash mtg.
- Tone control.
- 18 trans, 6 diodes.
- Long distance AM reception.

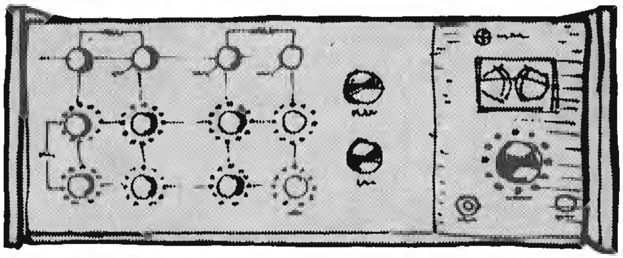
Available for 12V -VE gnd only.



$69.00

PLAYMASTER 145 KIT

8 INPUT STEREO/MONO MIXER

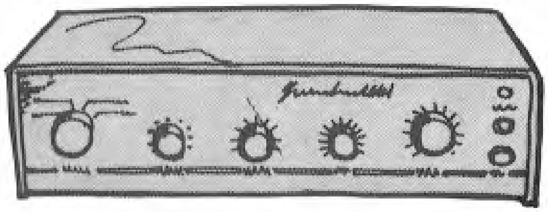


Ideal for hobbyist or professional use. $135.00. P&P $5.
This new multi-input mixer offers automatic muting, base/treble controls, headphone monitoring, signal metering and plug-in pre-amps for a wide variety of signal sources, e.g., mics, phono, tape deck, etc.

$135.00

ETI 440 25 WATT/CHANNEL

STEREO AMPLIFIER KIT

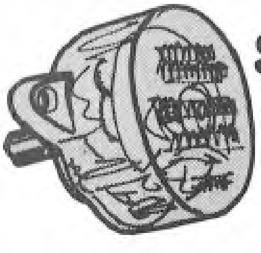


Big performance at a low price. $95.00. P&P $3.
Check the impressive performance figures on page 70, July ETI, and see for yourself. Simplicity of construction makes this great new kit a practical beginner's project, with 9 pages of instructions, etc., to make it easy for you.

$95.00

1 HOUR TIMER

$4.95. P&P 75c.
A great little gadget with a host of possible uses. Easy-to-mount and adjustable up to 1 hr with heavy duty 5 amp contacts.



$4.95

HEATHKIT®

Build your own test equipment?
NO PROBLEMS!

Heathkit
Sine-square Wave Generator

A low cost, portable signal source that will be invaluable in a variety of service and laboratory applications. Sine wave output is 1 Hz to 100 kHz with 5% accuracy and less than 0.1% distortion from 10 Hz to 20 kHz. Rise time is less than 50 ns on the 5 Hz to 100 kHz square wave output. The level of each output is independently adjustable. Both signals are floating and may be used simultaneously or independently. A front panel switch allows choice of internal or external load.

IG-18 PARTIAL SPECIFICATIONS — GENERAL: Frequency selection: 0-100 switch (steps 10), 0-10 switch (steps of 1), 0-1 control (vernier) & multiplier switch (x1, 10, 100, 1000). **SINE WAVE OUTPUT: Output voltage:** 8 ranges, 0.003 to 10 Vrms (full-scale) with 10 K ohm or higher external load. 6 ranges, 0.003 to 1 V (full scale) with 600 ohm internal or external load. **dB ranges:** —62 dB to +22 dB, —12 dB to +2 dB on meter and —50 to +20 dB on amplitude switch in 10 dB steps. +2 dB max into 600 ohm load. (0 dB = 1 mW in 600 ohm). **Output variation:** ±1 dB 10 Hz to 100 Hz. **Output indications:** Two voltage and one dB scale on meter. **Output impedance:** 10 V range: 0-1000 ohm; 3 V range: 800-1000 ohm; 1 V range and lower; 600 ohm. **Meter accuracy:** ±10% of full scale with proper load termination. **SQUARE WAVE OUTPUT: Output voltage (peak-to-peak):** .1, 1, 10 V into 2000 ohm load or higher. **Output impedance:** .1 V and 1 V ranges: 52 ohm; 10 range: up to 220 ohm. **Power requirements:** 105-125 or 210-250 VAC, 50/60 Hz, 6 watts.

Check operating parameters of any discrete semiconductor with your scope and the IT-1121 Curve Tracer

Anyone who works with solid-state circuits will appreciate the Heathkit IT-1121 Semiconductor Curve Tracer. Just connect it to any oscilloscope with horizontal sensitivity of 0.5 V/div. and vertical sensitivity of 1 V/div. and get an accurate display of operating parameters for virtually any discrete semiconductor. Devices such as bipolar transistors, diodes, SCRs, triacs, FETs, etc. can be inspected or tested for specific applications. Extra leads are included for tests of large devices or for in-circuit tests.

Kit IT-1121, 11 lbs.

IT-1121 SPECIFICATIONS — Sweep Voltage Ranges: 0-40 volts at 1 ampere max. 0-200 volts at 200 mA max. **Sweep Voltage Sampling:** .1, .2, .5, 1, 2, 5, 10, 20 and 50 V/div. ±3%. **Sweep Current Sampling:** .5, 1, 2, 5, 10, 50, 100 and 200 mA/div. ±3%. **Sweep Dissipation Resistors:** 0, 10, 50, 100, 500, 1000, 5000, 10 k, 50 k, 100 k, 500 k, 1 M ±10%. **Step Currents Available:** .002, .005, .01, .02, .05, .1, .2, 2, 5, and 10 mA/step, ±3%, ±250 nA offset current max. **Step Voltages Available:** .05, .1, .2, .5, and 1 volt/step, +3%, ±5mA maximum offset voltage. **Calibration Source:** 9 volts ±2% in 1 volt steps. **Oscilloscope Requirements:** Bandwidth to 20 kHz or greater. (DC-coupled oscilloscope is recommended). **Operating Temperature Range:** 10°C to 40°C. **Temperature** variation, referenced at 25°C, will have a maximum effect of ±1% on all other specifications. **Power Requirements:** 110 to 130 or 220 to 260 VAC. **Dimensions:** 4½" H x 11¼" W x 10" D.

Component testing is fast and accurate with the IT-121 In-Circuit FET/Transistor Tester

Single circuit board design makes the IT-121 an enjoyable two-evening project to assemble and the high performance at low cost makes it a top value service and design tool.

Kit IT-121, 6 lbs.,

IT-121 SPECIFICATIONS — DC Beta: 1 to 5000 in ranges of 1 to 50, 5 to 250, 10 to 500, 50 to 2500, 100 to 5000. **Collector currents available:** 1 mA, 5 mA, 10 mA, 100 mA, 500 mA, and 1 A. Gm: 0 to 50,000 µohms. **Leakage measurements:** Five ranges, 0 to 100 µA, 0 to 1 mA, 0 to 10 mA, 0 to 100 mA, 0 to 1 A. **Out-of-circuit accuracy:** ±5% for DC beta and leakage. **In-circuit accuracy:** Indicates good or bad transistor, FET, diode, SCR or triac. **Diode test:** Tests for forward conduction and blocking. **Unijunction transistor test:** Measures Veb$_2$s, Rbb, and emitter current (out-of-circuit). **Power Requirements:** Two 1½ V cells, (alkaline for best performance). **Dimensions:** 5" H x 9-7/16" W x 8-1/8" D.

Test transistors in- or out-of-circuit with the Heathkit IT-18

You don't have to remove transistors or diodes from the circuit when you use the Heathkit IT-18 In-circuit/Out-of-circuit Transistor Tester. Its low internal impedance and handy color-coded test leads assure easy, reliable in-circuit checks. The large, easy-to-read meter permits direct reading of DC Beta (gain) on two ranges, 2-100 and 20-1000. The IT-18 also makes out-of-circuit leakage measurements for transistors and diodes, range 0-5000 µA. It will also match and identify NPN or PNP transistors. The 1.5 V battery-powered circuit will not damage a transistor or diode that is incorrectly connected. Not for use with high power or switching transistors.

Kit IT-18, 4 lbs.

IT-18 SPECIFICATIONS — D.C. Beta: x1 range — 2 to 100, x10 range — 20 to 1000. **Out-of-circuit accuracy:** ±5%. **In-circuit accuracy:** Indicates good or bad. **Iceo** (out-of-circuit only) — — 0-5000 µA. **Icbo** (out-of-circuit only) 0-5000 µA diodes; forward or reverse current — 0.5000 µA. **Power:** One standard "D" cell (not supplied). **Dimensions:** 4½" H x 8½" W x 7-1/8" D.

WF WARBURTON FRANKI

ADELAIDE 356-7333 • BRISBANE 52-7255 • HOBART 23-1841
MELBOURNE 69-0151 • PERTH 65 7000 • SYDNEY 648-1711
• WELLINGTON N.Z. 698-272